P12115: Wandering Ambasador

Meeting Purpose: Detailed Design Review

Materials to be Reviewed:

1. Project Background and Approach
2. Critical Specs
3. Customer Needs and Engineering Specs
4. Risks
5. Software Review
6. Diagnostic GUI
7. Test Stand and Power Supply
8. Disconnect System
9. Voltage Regulator Redesign
10. Heat Sink
11. Test Procedure
12. Bill of Materials
13. MSDII Plan

Meeting Date: Friday, 2/24/12

Meeting Location: 09-3489

Meeting time:12-3:30pm

Meeting Timeline:

Start time	Topic of Review	Required Attendees
12:00	Project Summary	Prof. Slack, Dr.Becker
12:05	Critical Specs.	Prof. Slack, Dr.Becker
12:15	Risks	Prof. Slack, Dr.Becker
12:45	UML diagram	Dr. Mondragon, Dr. Becker, Prof. Slack,Dr. Sahin
12:55	Discussion	Dr. Mondragon, Dr. Becker, Prof. Slack, Dr. Sahin
1:10	Communication diagnostic between Pandaboard and computer	Dr. Mondragon, Prof. Slack, Dr.Becker, Dr. Sahin
1:20	Discussion	Dr. Mondragon, Prof. Slack, Dr.Becker, Dr. Sahin
1:35	Sonar Communication	Dr. Sahin, Prof. Slack, Dr.Becker
1:35	Test Stand	Prof. Slack, Dr.Becker
1:55	Disconnect System	Prof. Slack, Dr. Becker
2:05	Discussion	Prof. Slack, Dr.Becker
2:10	Conceptual PCB/Schematics	Prof. Slack, Dr.Becker
2:20	Voltage Regulator Redesign	Prof. Slack, Dr.Becker
2:35	Discussion	Prof. Slack, Dr.Becker
2:45	Power Supply for Test Stand	Prof. Slack, Dr.Becker

Core Team

Name	Role	Major	Discipline
Praneeth Pulusani	Team Lead	CE	Software, Interfacing and Controls
Dan Massar	Meeting Facilitator	EE	Electrical
Derek Badon	Edge Coordinator	EE	Electrical
Sam Stats	Edge Coordinator	ME	Mechanical, Quick Disconnect
Phil Tatti	Treasurer	EE	Electrical, Sonar, Interfacing
Sheena Mital	Treasurer	EE	Electrical
Michael Ciambella	Quality Control Specialist	ME	Mechanical, Labview
Anthony Lanza	Quality Control Specialist	EE	Electrical

Project Background

Over the past four years, RIT students have designed, assembled, and tested the Wandering Ambassador. They have succeeded in their goal of showcasing the creativity and aptitude of RIT students. Since the first year, the complexity of the project has grown immensely. The task of comprehending and understanding past modifications to enhance the project further has become a laborious task. Any further multidisciplinary modifications can only be done in a serial progression because of the current layout causing unnecessary time delays.

Project Statement

Our goal is to reduce the period in which a new group can familiarize themselves with the Wandering Ambassador. In addition, a comprehensive testing platform will be designed to allow quicker problem solving and multidisciplinary work to be performed in parallel.

Objectives/Scope:

1. Improve modularity of the system to be able to separate and reassemble the electrical and mechanical components rapidly.
2. Keep the electrical system organized and optimized for future improvements.
3. Enhance the campus experience for prospective students.
4. Showcase aptitude of RIT engineering students
5. Create a user friendly interface for detecting hardware malfunctions.
6. Tutorials for I2C interfaces and data analyzer.

Deliverables:

1. A test stand that will allow future teams to quickly troubleshoot and develop new electronic and software solutions.
2. A learning module on communications interfaces tailored to the Wandering Ambassador project that will allow a new group to quickly ascertain how to program and make changes to the ambassador.
3. An ambassador that wanders around the campus manually while reporting its coordinates.
4. A tutorial describing I2C interfaces

Expected Project Benefits

At present, prospective RIT students interact with human ambassadors who guide them around the campus. This project will help these students discover the possibilities an RIT education can provide. Students will be able to interact with The Wandering Ambassador to find directions, local weather, events, dining locations and other information pertaining to campus life. In addition, the proposed improvements and learning tools will help future engineering teams further develop the Wandering Ambassador platform.

Strategy & Approach

Assumptions & Constraints:

The team must have a well-rounded understanding of the current Wandering Ambassador robot in order to enable off-line development, experimentation, and debugging. The team must assume particular components of the current robot are operable. The ability to enable parallel development and create a modular system for upcoming teams will prove to be a constraint due to several technologies being developed simultaneously. The team will focus on design issues throughout the duration of the project in order to assist the development of future design iterations.

Issues & Risks:

- Increase reliability of Wandering Ambassador
- Redesign of selected systems to allow for increased functionality and addition of peripherals by future MSD teams
- Mitigate troubleshooting by creating a test stand, disconnect system and diagnostic GUI

Expectations and Outcome of Detailed Design Review

- Highlight limitations of proposed designs and subsystems
- Feedback from faculty regarding software solutions
- General comments and input from faculty
- Permission to move forward with design and order parts

Critical Specs

P12215 Wandering Ambassador Test Stand - Top Ten Engineering Specifications				
Engineering Specification (Listed in Order of Importance)	**Specification Description**	**Unit of Measure**	**Marginal value**	**Ideal Value**
Reliability	Keep current functionality of robot	issues/wk	1	0
Condense Microcontroller by programming with Pandaboard/PSoc		# of microcontrollers	1	0
Redesign and Refrabication of PCB Layout		binary	y	y
Mechanincal Breakaway to allow for Testing on Mule		binary	y	y
Implementation of Sensors while Limiting Sensory to Software Latency-Input Time		seconds	0.3	0.1
Establish Communication between Pandaboard and Computer	Send Information to Allow for Diagnostic GUI	binary	y	y
Create GUI to Allow for Diagnostic Mode Operation		binary	y	y
Create I2C and Various Tutorials for Future Groups		binary	y	y

Customer Needs

P12215 Wandering Ambassador Test Stand - Customer Needs			
Customer Need Number	Importance	Description	Comments/Status
CN1	7	Uphold Specifications from Previous Projects	
CN2	6	Create Test Environment	
CN3	9	Quick Disconnect	
CN4	9	Redesign and Simplification of Existing Systems without Loss of Performance	
CN5	9	Correct overheating of voltage regulater	
CN6	6	Reduce Learning Curve for Future Groups	
CN7	9	Partition Computer/Electrical Systems from Mechanical Systems	
CN8	6	Software Development Performance Enhancement	

Engineering Specs

P12215 Wandering Ambassador Test Stand - Engineering Specifications

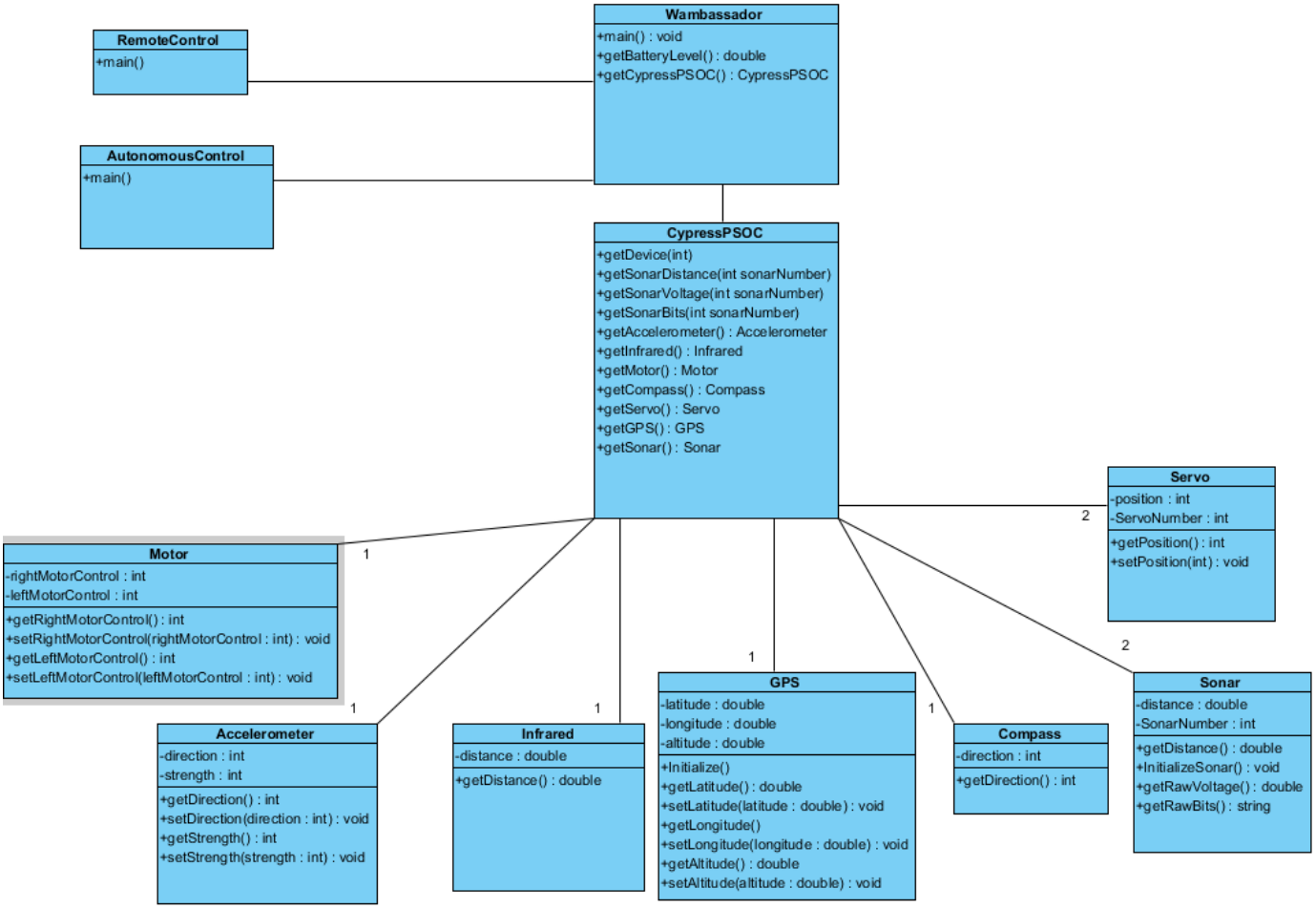
Engr. Spec #	Source	Specification	Description	Unit of Measure	Marginal value	Ideal Value	Comments/Status
EN1	CN1	Radius Object Detection	proximity of robot to front/back of robot	in	24	12	
EN2	CN1	Angle of Object Dectection (Field of View)	object elevation relative to robot	°	60	360	
EN3	CN1	Edge Hangover Distance	detect distance from robot to ground	in	2	0	
EN4	CN1	Stopping Distance		in	5	1	
EN5	CN1	Solar Panel Power Output		watts	1.00	2.50	Implementation undecided (low priority)
EN6	CN1	Maximum Bump Force		lbs	<10	<5	
EN7	CN1	Hours of Continous Operation		hrs	2	10	
EN8	CN1	Reliability		issues/wk	1.00	0.00	
EN9	CN1	Ability to Switch Input Peripherals	Operate autonomously or via user input peripherals	binary	y	y	
EN10	CN1	Child cannot entangle fingers in drivetrain		binary	y	y	Completed by previous group
EN11	CN1	Core Components are Visible from a Distance		ft	4.00	12.00	
EN12	CN1	Sensor Output Latency-Input to Software Recognition Time		sec	0.30	0.10	
EN13	CN1	Wireless Radio					
EN14	CN3	Standard Connectors (sockets, USB, MicroSD)		%	75%	100%	
EN15	CN2/CN6	Create diagnostic GUI to quickly debug hardware problems					
EN16	CN2	Debug Diagnostic Mode Operation		binary	y	y	Labview/LEDs
EN17	CN4	Ensure wandering ambassador is within processing limits of the Beagle board	stimulus to response time	seconds			
EN18	CN4	Redesign and Refabricate of PCB Layout					
EN19	CN2	Interface Robot with Labview					
EN20	CN3	Mechanical Breakaway to Disconnect Electrical Components					
EN21	CN4	Increase Breadboard Area					
EN22	CN4	Ability to Add Additional Components for Increased Functionality					
EN23	CN4/CN2	Incorporate Data Aqusition (DAQ) in Parallel with Sensor					Elaborate on Potential Output
EN24	CN5	Redesign Voltage Regulator	5 Vdc				
EN25	CN6	Create I2C Tutorial					
EN26	CN6	Create CAN Tutorial					
EN27	CN6	Data Analyzer Tutorial					
EN28	CN7/CN2	Evaluate Sensor Functionality on Test Stand					
EN29	CN8	Implement the sensor and servo controllers					
EN30	CN8	Evaluate Driver Compability of Beagle Board					
EN31	CN8	Relay Coordinate from GPS		binary	y	y	

Risks

MSD Project Risk Assessment Template – P12215 Wandering Ambassador Test Stand

ID	Risk Item	Effect	Cause	Likelihood	Severity	Importance	Action to Minimize Risk	Owner
	Describe the risk briefly	*What is the effect on any or all of the project deliverables if the cause actually happens?*	*What are the possible cause(s) of this risk?*			*L*S*	*What action(s) will you take (and by when) to prevent, reduce the impact of, or transfer the risk of this occurring?*	*Who is responsible for following through on mitigation?*
1	Limitations and processing power of pandaboard	Not every system can work simultaneously	Too many peripherals	2	1	2	Simplify programming, reduce sensors	Praneeth, Phil
2	Developing for Pandaboard	Robot would not function	Learning curve	2	3	6	Seek help from faculty	Praneeth
3	Removing microcontrollers	Unable to reprogram/ redesign board	Trouble interfacing with sensors/I2C	1	2	2	Work with experts, consult with previous groups	Phil
4	Damage to the pandaboard	Would need to roll back to beagleboard	Static hazard, drop hazard, power supply failure	1	3	3	Seeking to acquire ESD straps	Praneeth
5	PCB redesign	Robot would not be able to function unassisted	Design flaws	2	3	6	Leave time for board revisions and debugging	Sheena, Derek
6	Budget	Inability to order all desired parts	Price of desired components	2	2	4	Comparative shopping to ensure parts are purchased at best price	Sheena, Phil
7	Peripherals driven by voltage regulators may draw more current than regulators are capable of supplying	Peripherals driven by voltage regulators may draw more current than regulators are capable of supplying	Team adds too many peripherals to voltage regulator load. A voltage regulator not capable of supplying enough current is implemented in the design	1	3	3	Sum required current by all peripherals to ensure it does not exceed output current of voltage regulator Leave at least 1 A margin between capability of voltage regulator and load current required by peripherals	Dan
8	Operating temperature of voltage regulators	When voltage regulators overheat, they will shut off to prevent damage	Load current exceeds output current capability of voltage regulators	1	3	3	Mount a heat sink to help dissipate heat. Keep load current below output current rating of regulator	Tony, Dan
9	Operator unaware of load/stress putting on voltage regulators	Peripherals could draw more current than voltage regulators capable of supplying, causing them to overheat and shut down	Operator complacency. Unable to alert operator regulators are operating at	2	3	6	LED to indicate regulator supplying 5V. Test points to measure output voltage. Implement a method for measuring current	Dan
10	Unable to have direct connection between voltage regulator and heat sink	Voltage regulators will overheat causing robot to shut off	Improper placement of voltage regulators on edge of PCB board	1	3	2	Ensure voltage regulators are placed on edge of PCB board	Tony, Derek
11	Inability of Establishing TCP connection between Computer and Pandaboard	Unable to receive signals for debugging diagnostic	Lack of familiarity with TCP Connections	2	1	2	Research other options and coordinate with teachers/groups member who are familiar with TCP	Tony, Mike
12	Designing Qt gui to have real time updates	Debugging gui will have snapshots of the Ambassador's signals	Lack of programming knowledge	2	1	2	Research and coordinate with teachers/ groups member who have more programming experience	Mike, Tony, Praneeth

UML Diagram

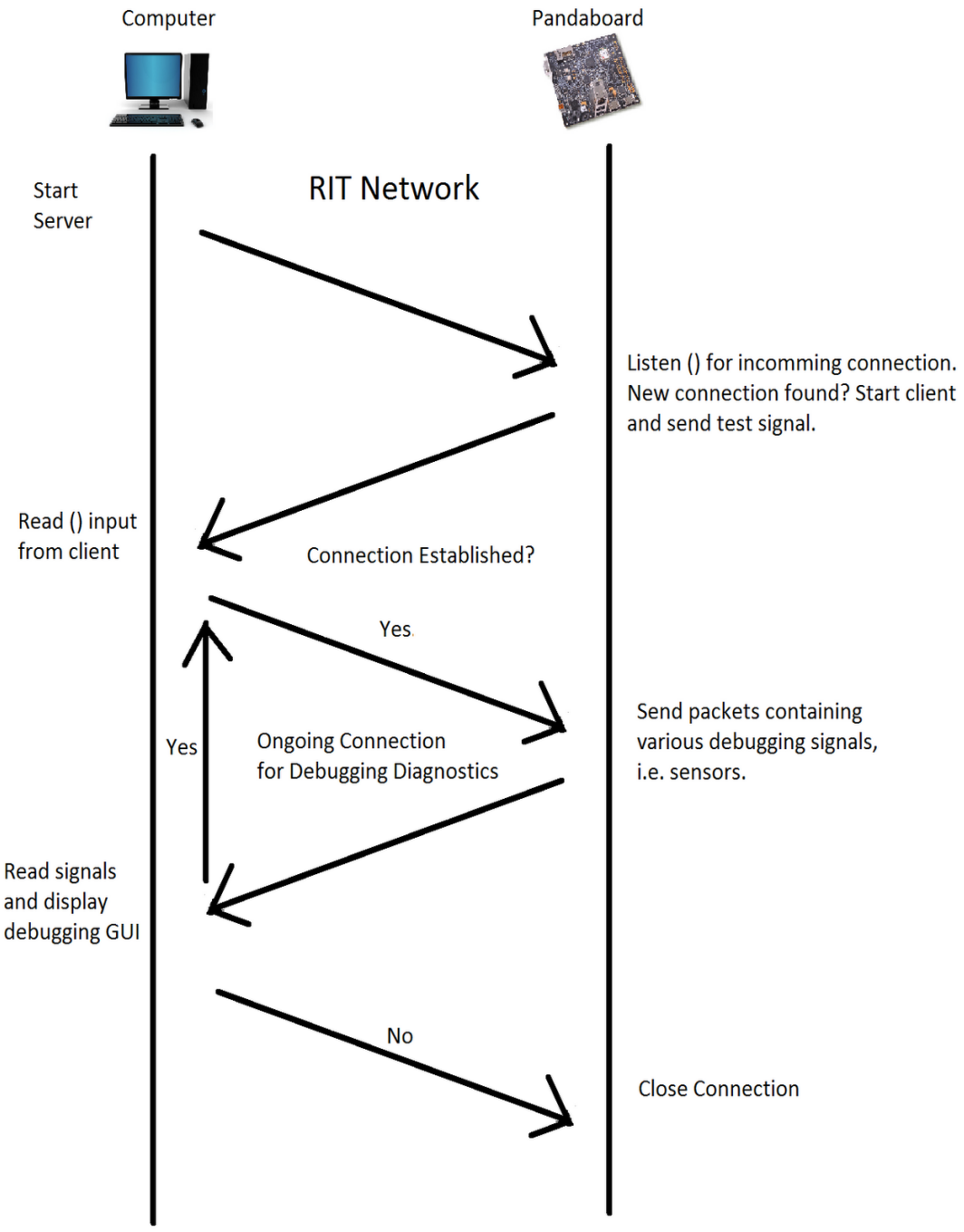


Discussion

What tools can we use to make out development easier?

Will polling performance be very noticeably inferior to interrupts?

Communication Diagnostics with Transmission Control Protocol

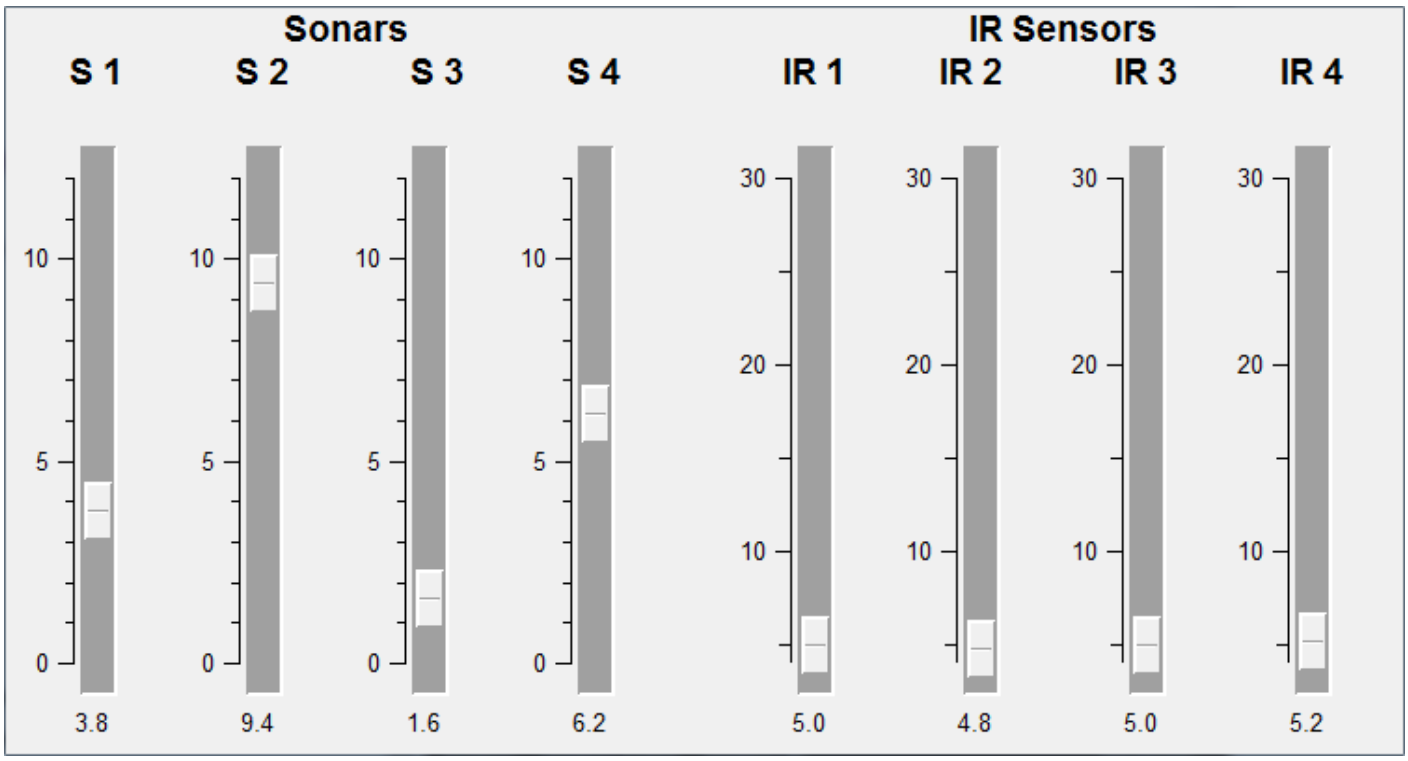


TCP Datagram

Diagnostic GUI

```
QwtSlider *Slider::createSlider(QWidget *parent, int sliderType) const
{
  QwtSlider *slider = NULL;
  switch( sliderType )
  {
case 2:
     {
        slider = new QwtSlider(parent, Qt::Vertical,
           QwtSlider::LeftScale, QwtSlider::Trough);
        //slider->setHandleSize( 12, 25 );
        slider->setRange(4, 30, .2, 2);
        slider->setValue(8.0);
        break;
     }
}

SliderDemo::SliderDemo(QWidget *p):
  QWidget(p)
{
  int i;

  Layout *IRSensors = new Layout(Qt::Horizontal);
  for ( i = 0; i < 4; i++ )
     IRSensors->addWidget(new Slider(this, 2));
     IRSensors->addStretch();

  Layout *SonarSensors = new Layout(Qt::Horizontal);
  for ( i = 0; i < 4; i++ )
     SonarSensors->addWidget(new Slider(this, 3));
     SonarSensors->addStretch();

  QLabel *SonarTitle = new QLabel("Sonars \nS 1          S 2          S 3          S 4", this);
  SonarTitle->setFont(QFont("Helvetica", 14, QFont::Bold));
  SonarTitle->setAlignment(Qt::AlignHCenter);
```

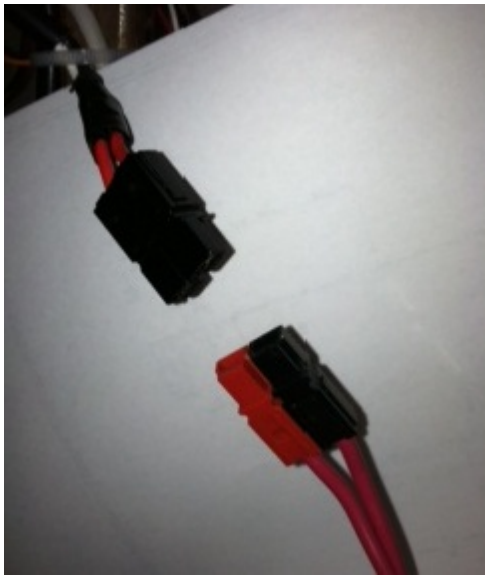
```
  Layout *layout1 = new Layout(Qt::Vertical);
  layout1->addWidget(vTitle, 0);
  layout1->addLayout(SonarSensors, 10);
Layout *mainLayout = new Layout(Qt::Horizontal, this);
  mainLayout->addLayout(layout1);
  mainLayout->addLayout(layout2);
}
int main (int argc, char **argv)
{
  QApplication a(argc, argv);
  QApplication::setFont(QFont("Helvetica",10));
  SliderDemo w;
  w.resize(750,400);
  w.show();
  return a.exec();
}
```



Power Supply for Test Stand

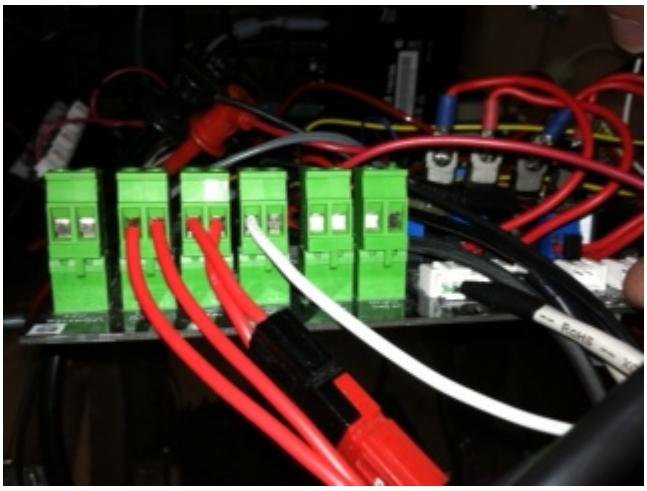
- Power Supply for Wandering Ambassador
    - DieHard Marine Deep Cycle/RV Battery
- The figures below demonstrate how the power supply on the robot connects to the PCB

Connecting Wire to PCB



Power Supply Disconnect

Fused Connector on PCB for Power Supply



Power Supply Connector on PCB

Proposed Power Supply for Test Stand

- Use a Magna Power-12V Lawn Mower battery
  - Price: $34.98

Magna Power 12-Volt Mowers Battery

Item #: 335988 | Model #: CB14LA2FP

5 reviews | Write a review

$34.98

Description | Specifications | Reviews | Q&A

Got an update or addition to this product's details? Share it here.

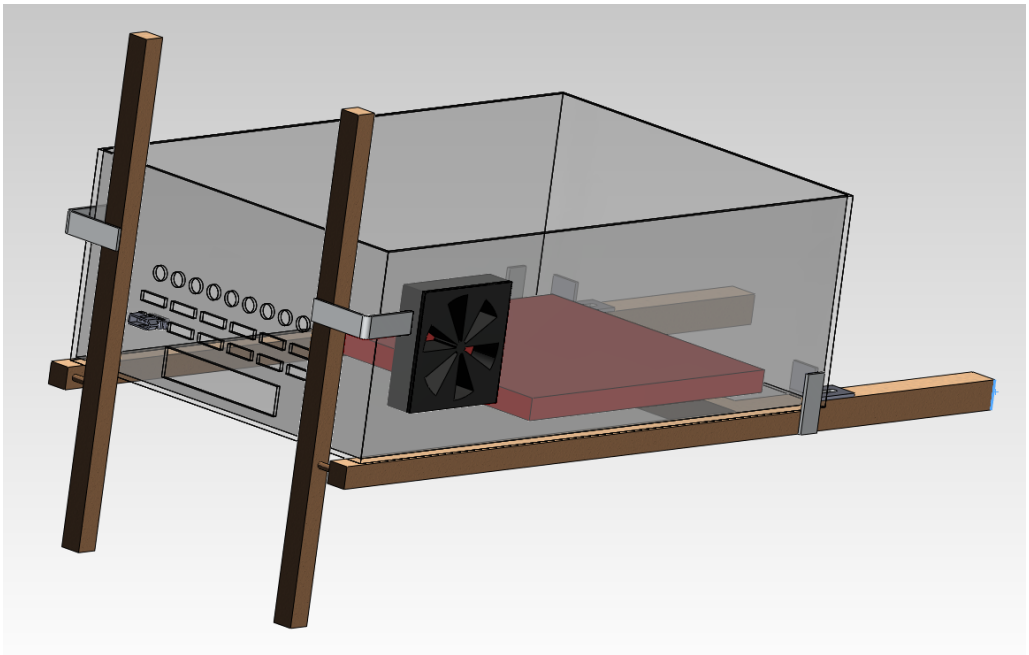
Application	Mowers	Weight (lbs.)	7.37
Height (Inches)	6.8	Terminals	Left
Reference Crank Amps-32 degrees F (Amps)	0.0	Length (Inches)	15.3
Voltage (Volts)	12.0	Width (Inches)	3.5
Maintenance-Free	No		

Proposed Battery for Test Stand

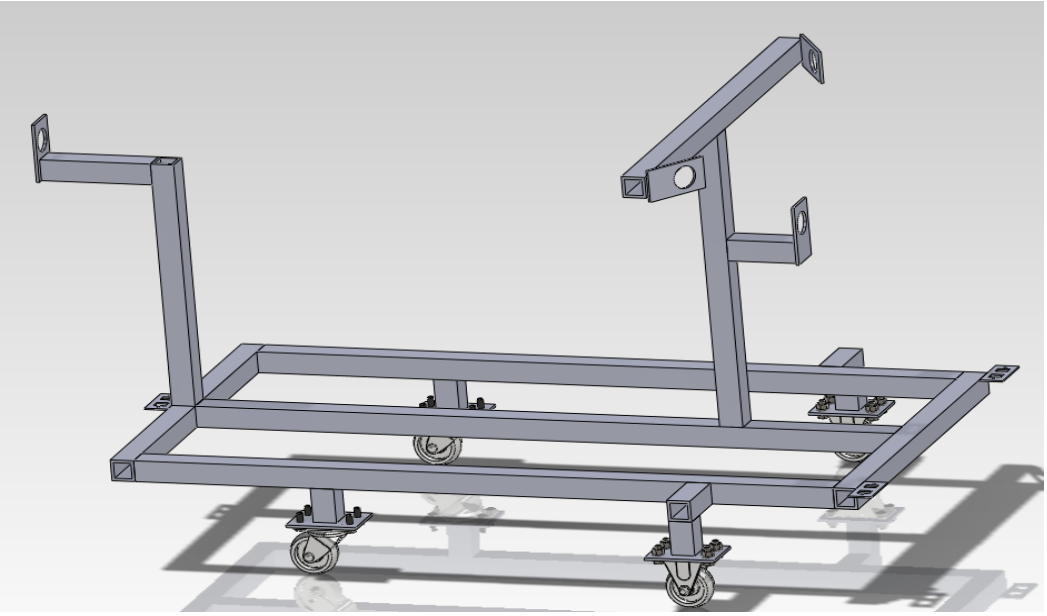
Mechanical

Quick Disconnect System

One simple and viable design is using movable brackets which will constrain electronics housing in place horizontally and laterally. I think this would be simple and effective since we really do not need to worry about large amounts of movement in the vertical direction which is not constrained.

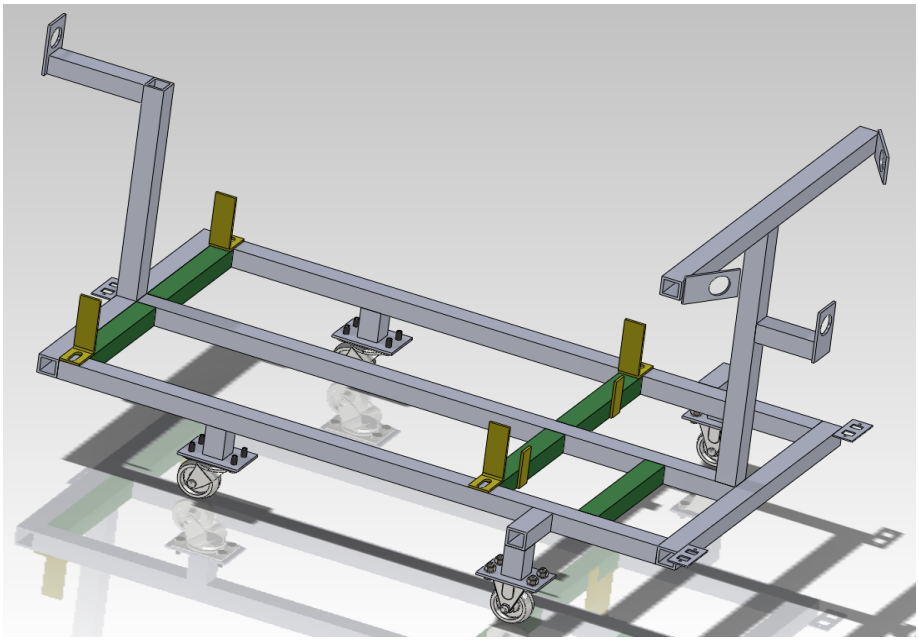


The current design of the mule:



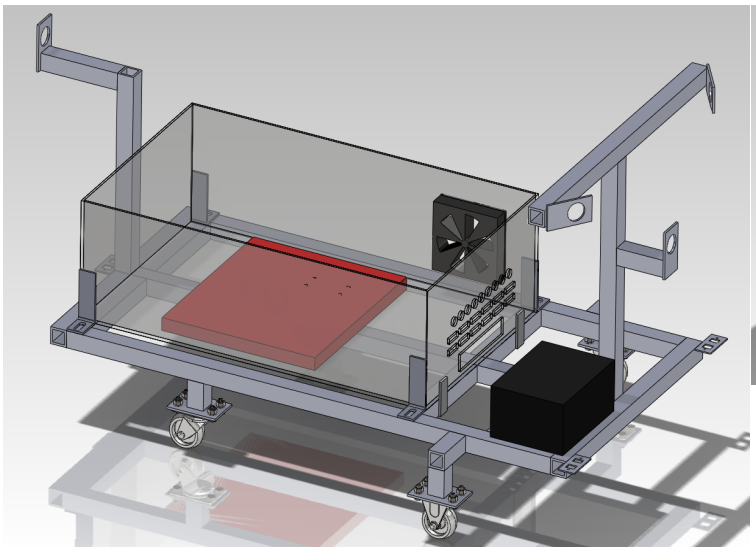
This is inadequate for out needs due to the dimensions of the body and placement of the front sonar stand which will inhibit the quick disconnect ports on the electronic housing.

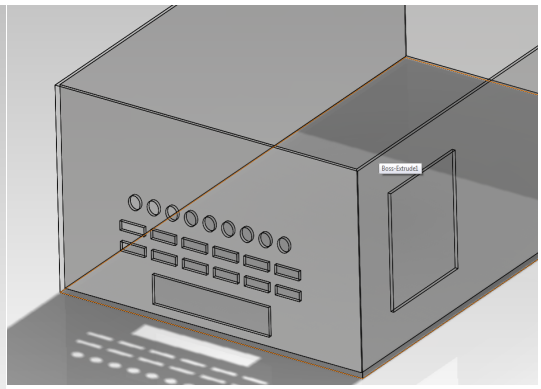
These are the design changes we are proposing:



- In green we have cross bars that will be installed to support the electronics housing and the battery that will be powering they system when it is on the mule.
- In Yellow are the brackets to constrain the electronics housing in the X and Y direction. Two of these brackets will be slotted allowing them to be at variable distances for easy removal of the housing.
- Finally we will need to move the front sonar stand forward to allow access to the quick disconnect ports in front of the electronics housing.

This is what the test stand will look like when fully assembled.





In order to make all the sensors quickly disconnect from the electronic housing we are going to install multi port wire connectors which can easily be unplugged. This will allow for no changes to be made inside the electronic housing when the system is being moved.

We are going with a single plug per device for simplicity when changing the system. If we were using a block plug it would be harder to disconnect a single device to test it and with a good labeling system there should be no confusion.

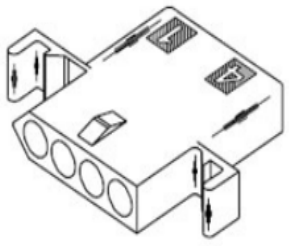
List of quick disconnect ports:

- USB hub
- 1X2, 1X3, and 1X4 directional Molex connectors
- Female to female HDMI port
- Banana clips
- Power adaptor ports

All plugs will be color coated and labeled to ensure quick disconnection and reconnection when moving the electronics housing to prevent any miss-connections.

Part Number: 0003091042
Status: Active
Overview: standard_093
Description: 2.36mm Diameter Standard .093" Pin and Socket Receptacle Housing, 4 Circuits, Single Row

Documents:
3D Model
Drawing (PDF)
Product Specification PS-02-09 (PDF)
Product Specification PS-43660-9999 (PDF)
RoHS Certificate of Compliance (PDF)



Series
image - Reference only

Agency Certification

CSA	LR19980
UL	E29179

General

Product Family	Crimp Housings
Series	1490
Application	Power, Wire-to-Wire
Comments	14.0A max. can be achieved when housing is used with 42477 or 42478 terminals
Overview	standard_093
Product Name	Standard .093"

Physical

Circuits (maximum)	4
Circuits Detail	(1 x 4)
Color - Resin	Natural
Flammability	94V-2
Gender	Dual
Glow-Wire Compliant	No
Material - Resin	Nylon
Number of Rows	1
Packaging Type	Bag
Panel Mount	No
Pitch - Mating Interface	5.03mm
Stackable	No
Temperature Range - Operating	-40°C to +105°C

Electrical

Current - Maximum per Contact	11A

Material Info

Old Part Number	1490-R1

Reference - Drawing Numbers

Product Specification	PS-02-09, PS-43660-9999
Sales Drawing	SD-1490-*

EU RoHS | **China RoHS**
ELV and RoHS Compliant
REACH SVHC
Contains SVHC: No
Low-Halogen Status
Low-Halogen

Need more information on product environmental compliance?

Email productcompliance@molex.com
For a multiple part number RoHS Certificate of Compliance, click here

Please visit the Contact Us section for any non-product compliance questions.

Search Parts in this Series
1490Series

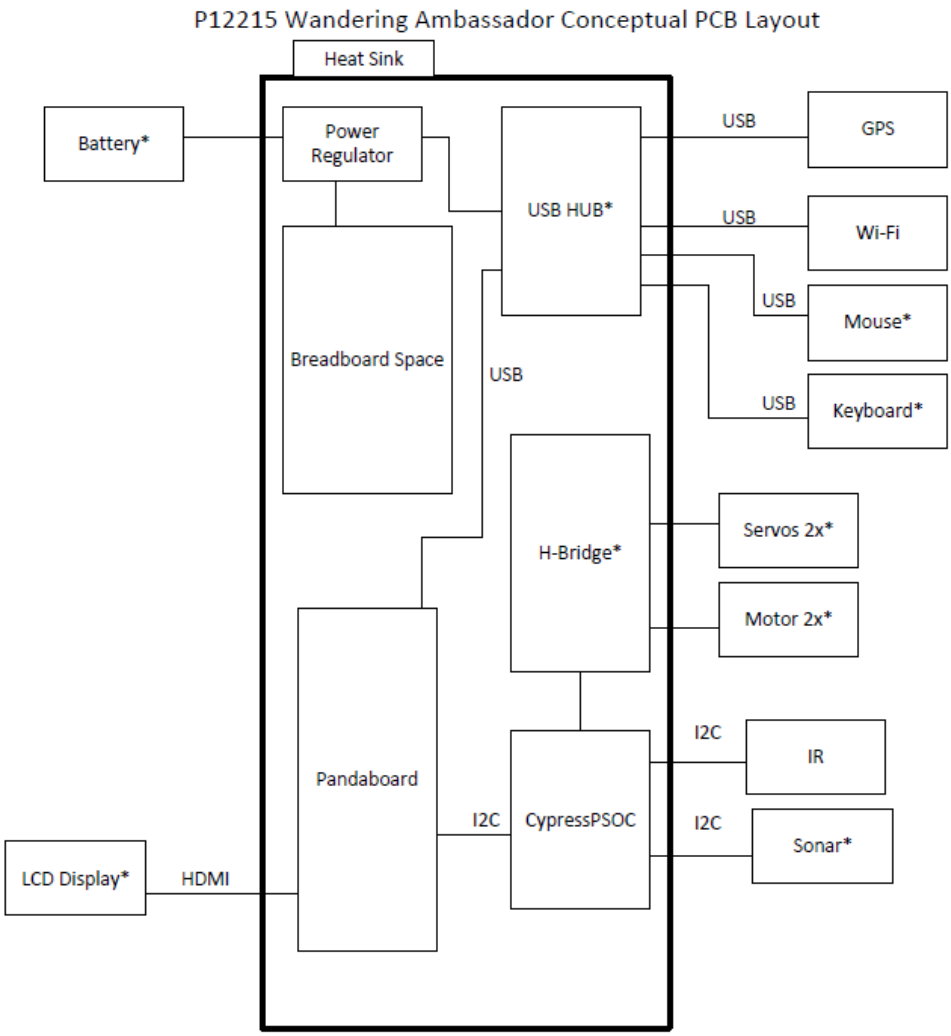
Mates With
3099 shrouded PCB connector, 1490p

Use With
1189 Crimp Terminals, 1190 Crimp Terminals, 1376 Male PC Tail Terminals, 1377 Female PC Tail Terminals, 1380 Male Crimp Terminals, 1381 Female Crimp Terminals, 1433 Crimp Terminals, 1434 Male Crimp Terminals, 1973

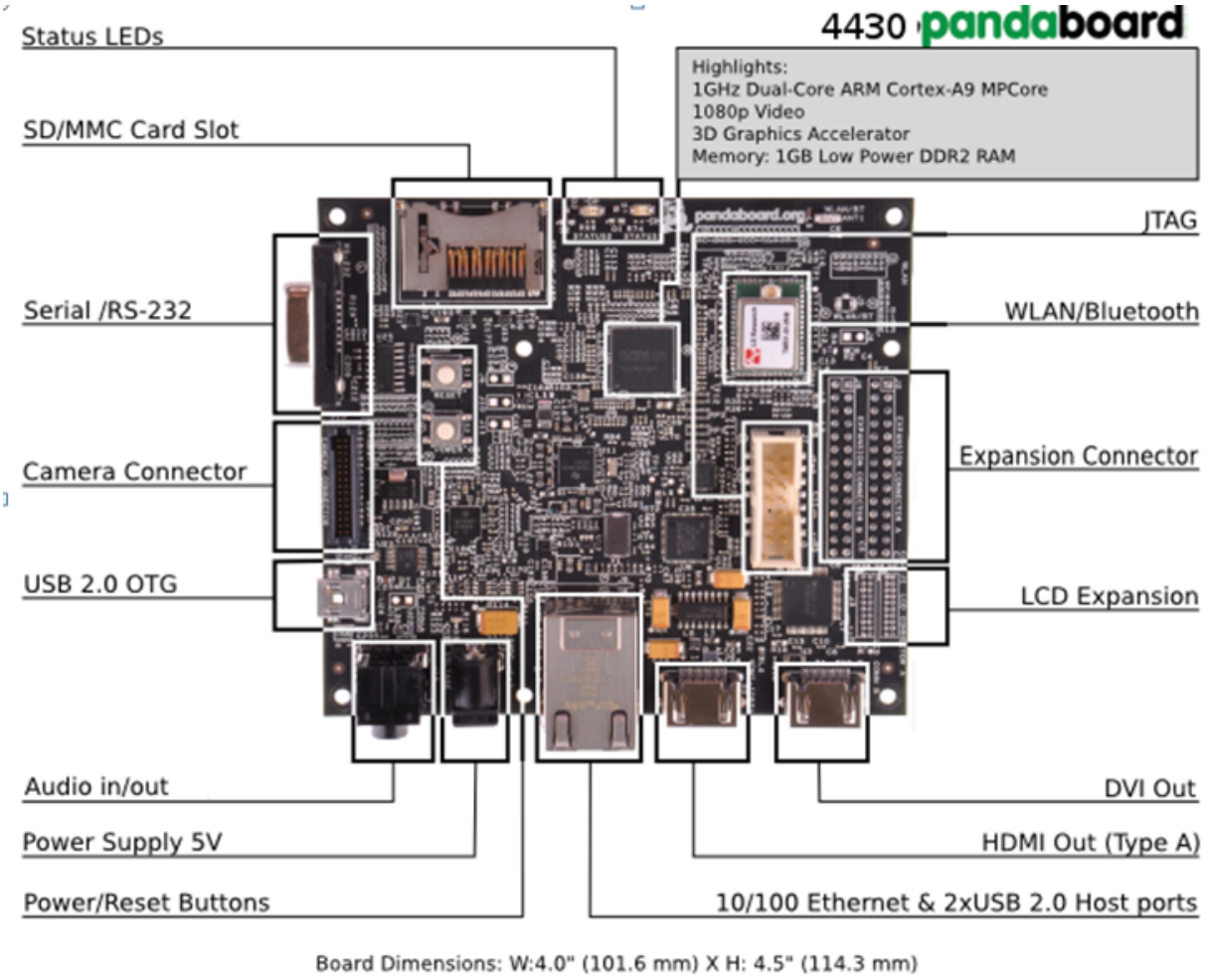
Disconnect Procedures: From the wandering ambassador to the mule

1) Power down the ambassador
2) Disconnect all the external components from the electronic housing
3) Lift the electronic housing vertically up to remove it from the ambassador
4) Place the electronic housing within the bracketing system on the mule
5) Reconnect all the sensors that will be tested according to the color code
6) Reconnect the power to the electronic housing
7) Power up the mule

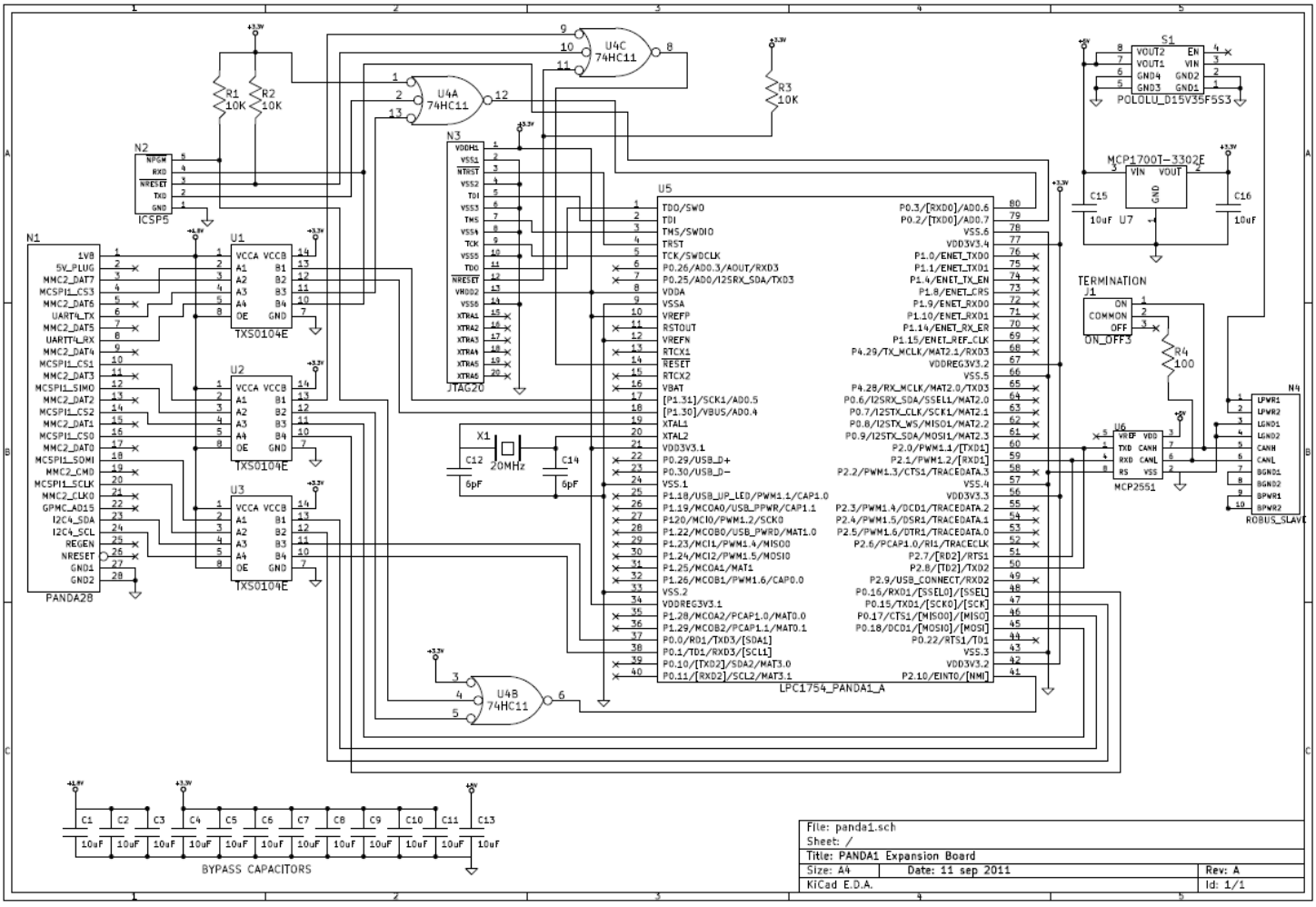
Future Conceptual PCB



Pandaboard Overview



Pandaboard Pinouts

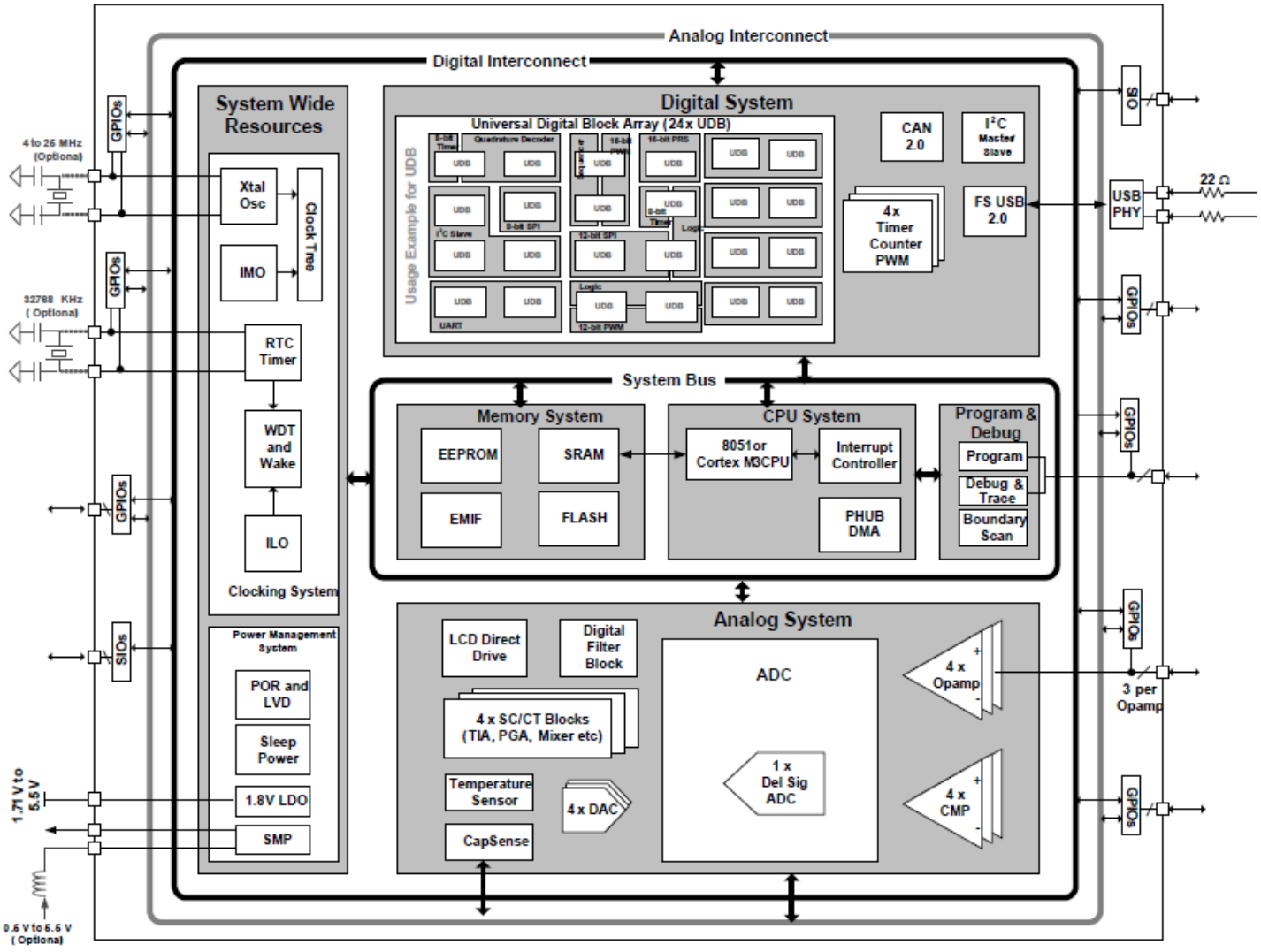


Pandaboard vs Beagleboard pinouts

PIN	Beagle/BeagleXM	Panda ES / Panda
1	1V8	1V8
2	5V	5V
3	MMC2_DAT7	MMC2_DAT7
4	MCBSP3_DX	MCSPI1_CS3
5	MMC2_DAT6	MMC2_DAT6
6	UART2_TX	UART4_TX
7	MMC2_DAT5	MMC2_DAT5
8	UART2_TX	UART4_TX
9	MMC2_DAT4	MMC2_DAT4
10	MCBSP3_DR	MCSPI1_CS1
11	MMC2_DAT3	MMC2_DAT3
12	MCSPI4_SIMO	MCSPI1_SIMO
13	MMC2_DAT2	MMC2_DAT2
14	MCBSP1_CLKX	MCSPI1_CS2
15	MMC2_DAT1	MMC2_DAT1
16	MCSPI4_CS0	MCSPI1_CS0
17	MMC2_DAT0	MMC2_DAT0
18	MCSPI4_SOMI	MCSPI1_SOMI
19	MMC2_CMD	MMC2_CMD
20	MCSPI4_SCLK	MCSPI1_SCLK
21	MMC2_CLK0	MMC2_CLK0
22	MCBSP1_FSR	GPMC_AD15
23	I2C2_SDA	I2C4_SDA
24	I2C2_SCL	I2C4_SCL
25	REGEN	REGEN
26	nRESET	nRESET
27	GND	GND
28	GND	GND

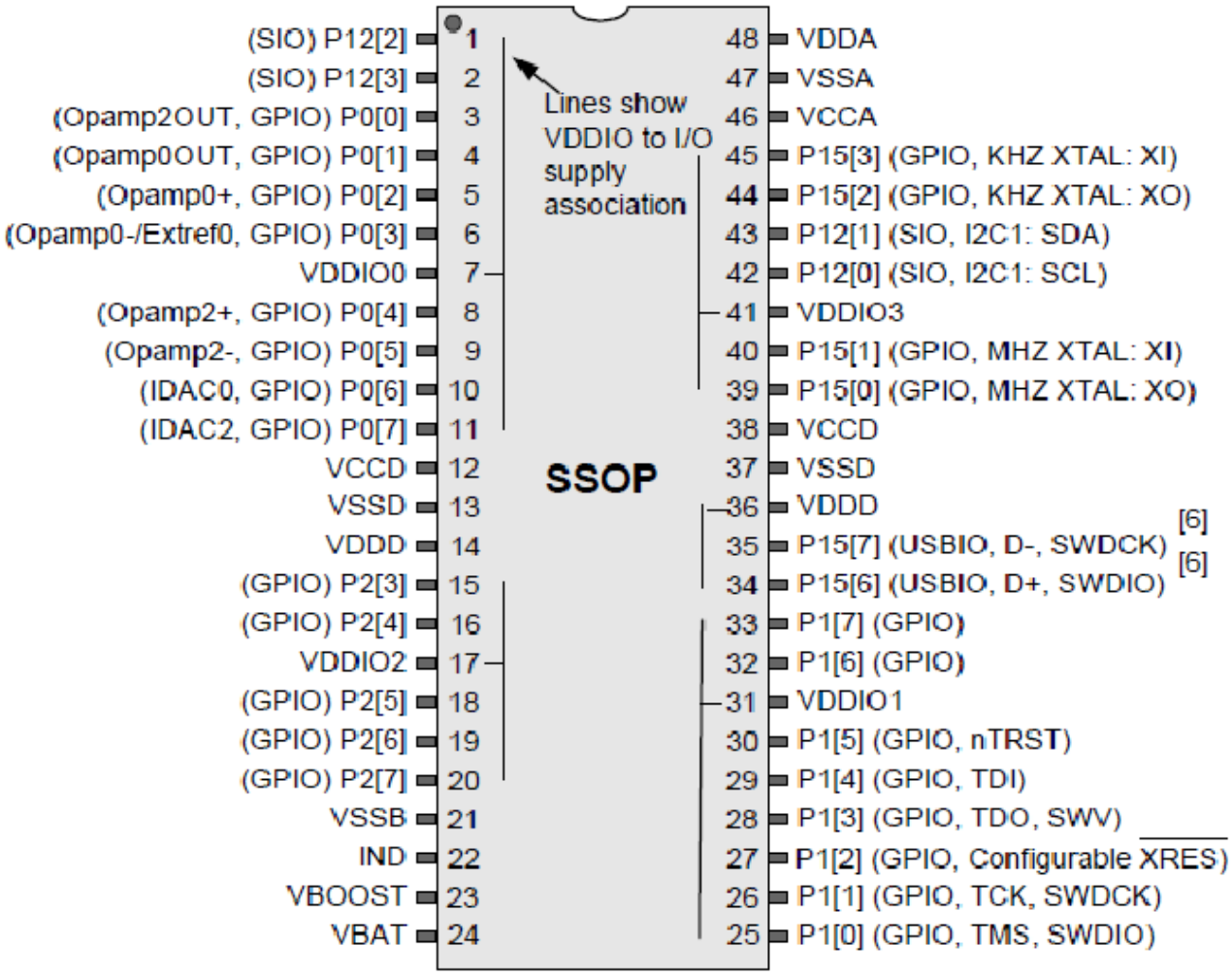
Cypress PSoC

Figure 1-1. Simplified Block Diagram

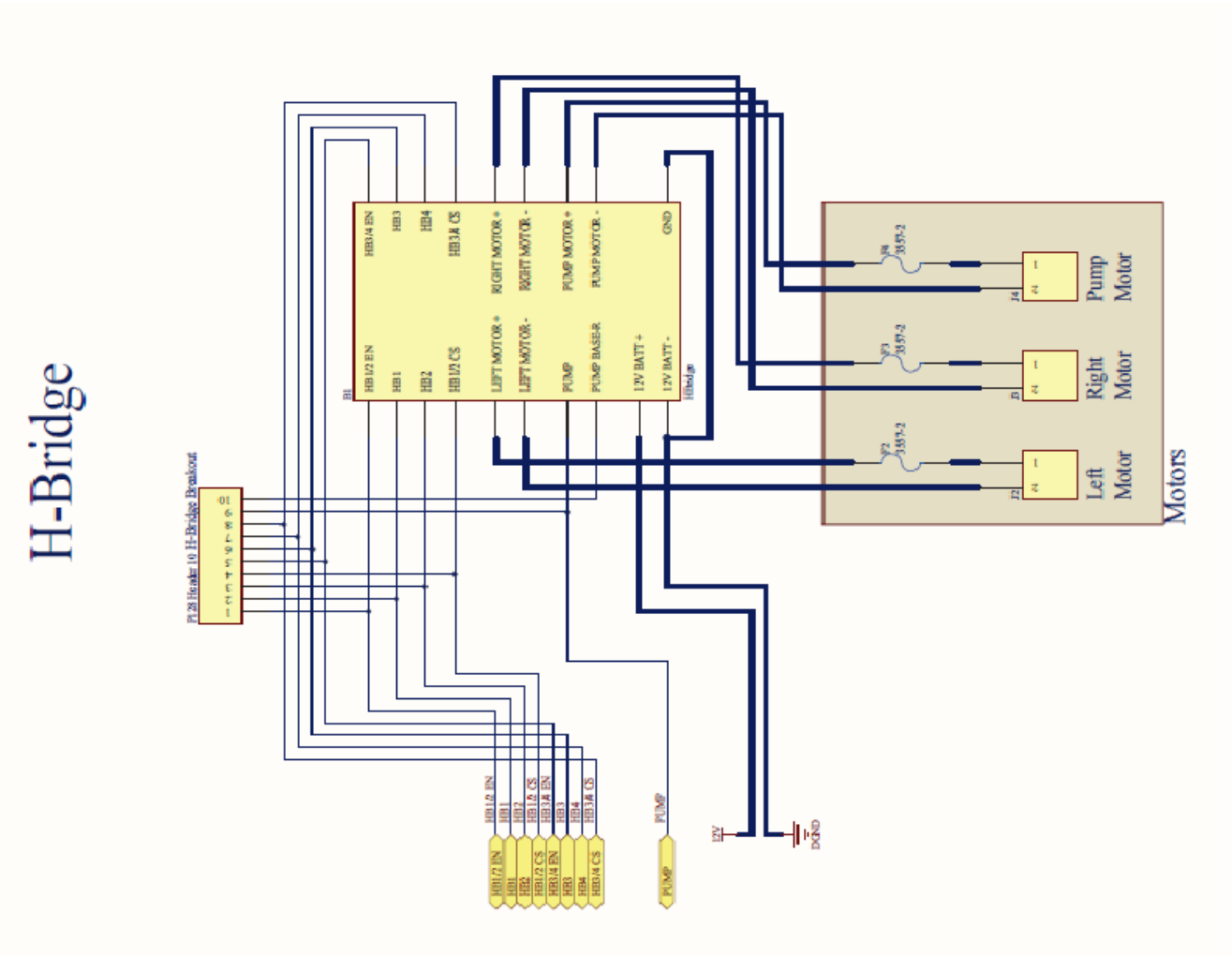


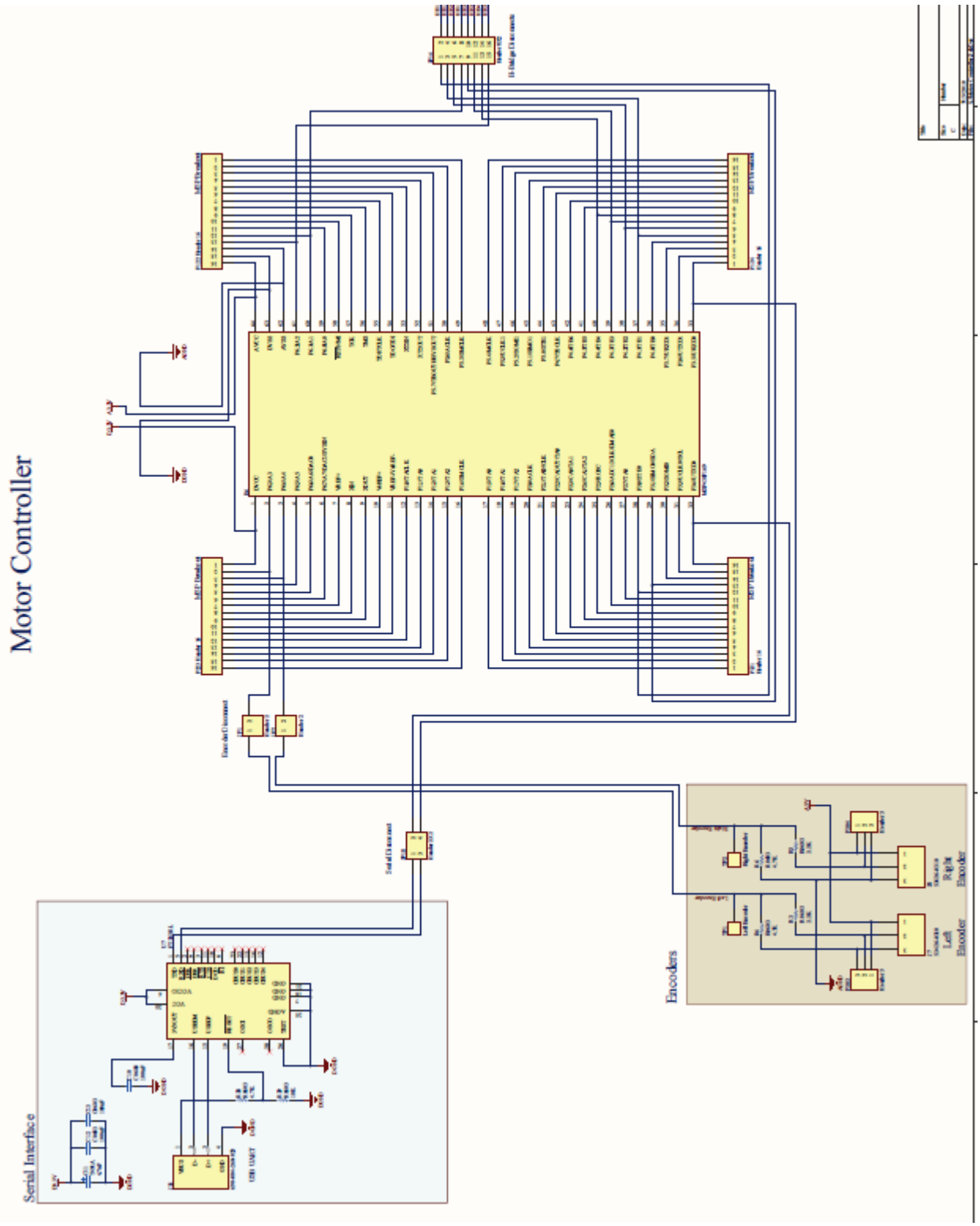
Cypress PSoC

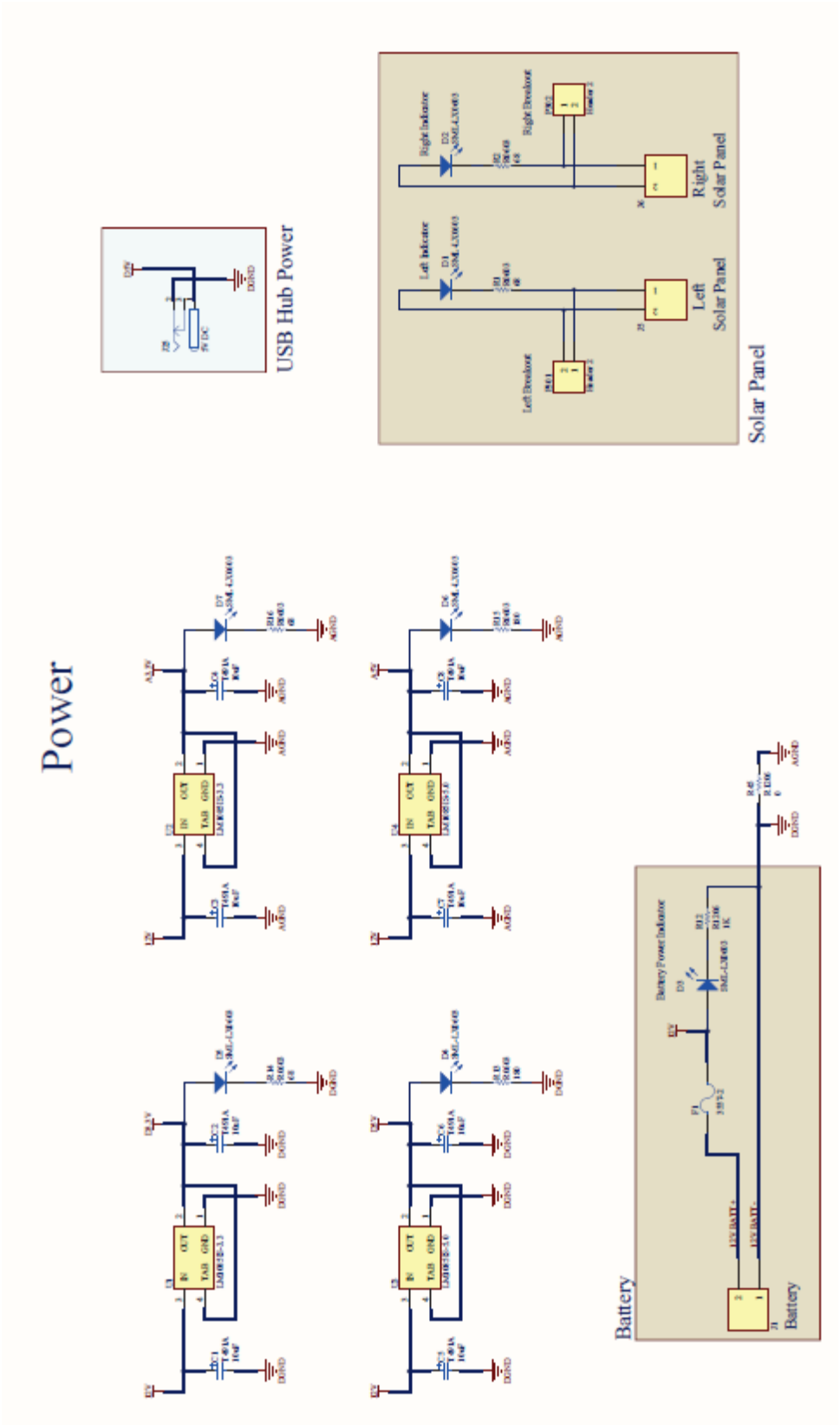
Figure 2-1. 48-pin SSOP Part Pinout



H-Bridge

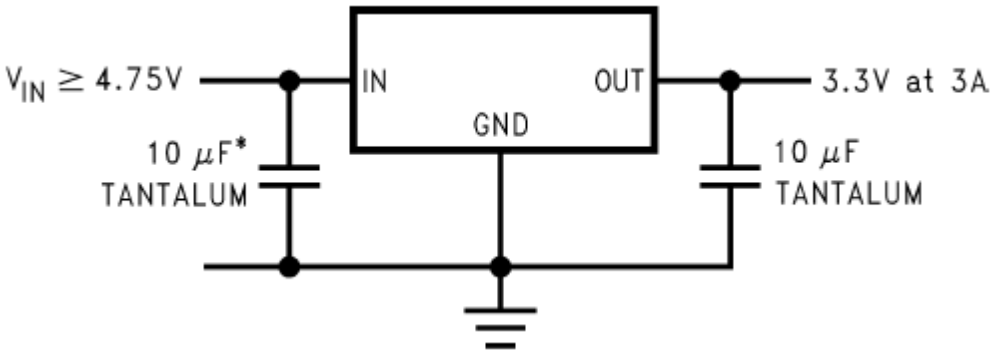

HB1/4 EN
HB3
HB4
HB3/4 CS
RIGHT MOTOR +
RIGHT MOTOR -
PUMP MOTOR +
PUMP MOTOR -
GND
HB1/2 EN
HB1
HB2
HB1/2 CS
LEFT MOTOR +
LEFT MOTOR -
PUMP
PUMP BASE-R
12V BATT +
12V BATT -
HBridge
J4
Pump Motor
J3
Right Motor
J2
Left Motor
Motors
PUMP
12V
DGND


Motor Controller
Serial Interface
Encoders
Right Encoder
Left Encoder

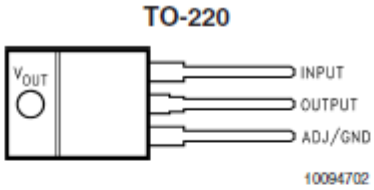

Power
USB Hub Power
Solar Panel
Left Solar Panel
Right Solar Panel
Battery

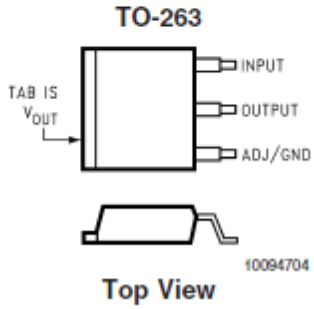
Voltage Regulator Redesign

Current Design



LM1085 5V Voltage Regulator





LM1085 Package

- LM1085 5V Regulator
  - output current: 3A

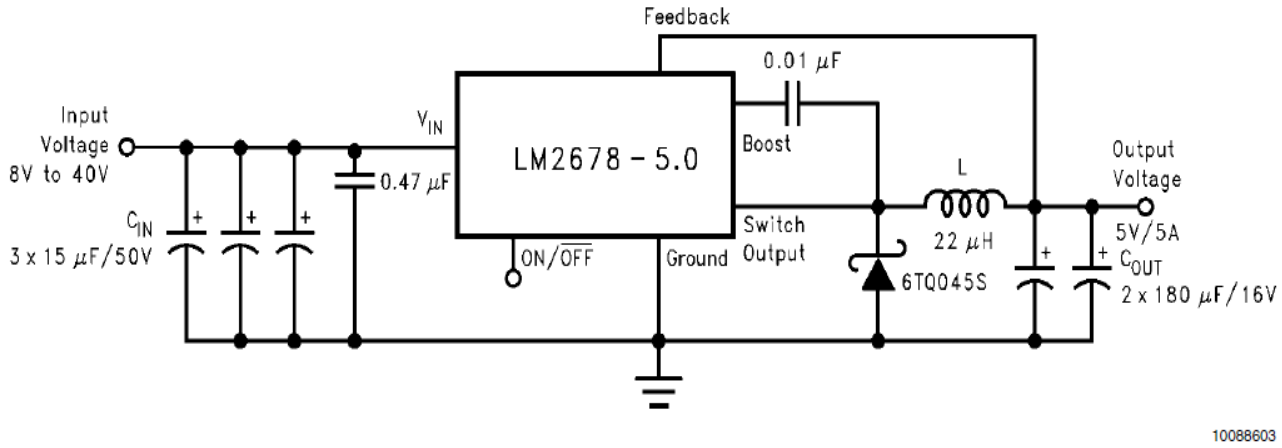
Loads on "Digital 5V" Voltage Regulator Current Configuration	
Peripheral	**Current (A)**
Beagleboard	2.5
Compass Module	0.045
USB Hub	2.5
Total Amps	5.045

Loads on LM1085 “Digital 5V” Voltage Regulator

Loads on "Digital 5V" Voltage Regulator Proposed Configuration	
Peripheral	**Current (A)**
Pandaboard	4
Compass Module	0.045
USB Hub	2.5
Total Amps	6.545

Proposed Loads on LM1085 “Digital 5V” Voltage Regulator

Proposed Design



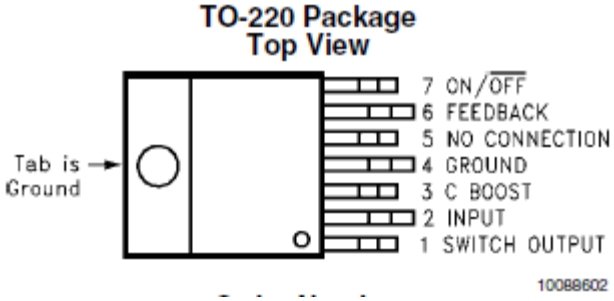
LM2678-5.0V Voltage Regulator

- Load of 6.545A will be split up between two LM2678 voltage regulators
- One LM2678 reserved exclusively for Pandaboard
- One LM2678 reserved for USB Hub and Compass Module
    - additional current available for expansion

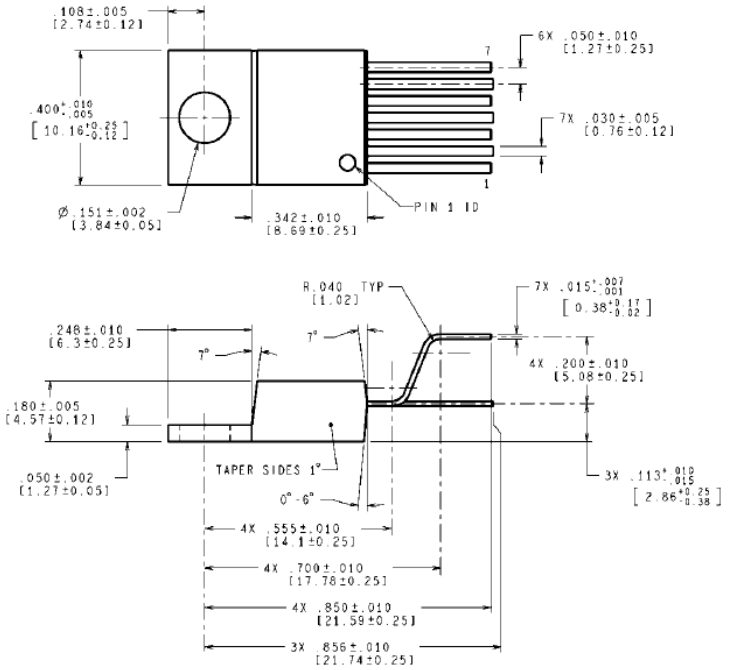
Proposed Voltage Regulator Design			
Panda Board Voltage Regulator		New "Digital 5V" Supply	
Peripheral	Current (A)	Peripheral	Current (A)
Pandaboard	4	USB Hub	2.5
		Compass Module	0.045
Total Amps	4	Total Amps	2.545
Margin	1	Margin	2.455

Proposed Voltage Regulator Design

The LM2678



LM2678



CONTROLING DIMENSIONS IS INCH
VALUES IN [ ] ARE MILLIMETERS

TA07B (Rev E)

TO-220 Power Package
Order Number LM2678T-3.3, LM2678T-5.0, LM2678T-12 or LM2678T-ADJ
NS Package Number TA07B

Package

Physical Description of TO-220 Package

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Input Supply Voltage	45V
ON/OFF Pin Voltage	−0.1V to 6V
Switch Voltage to Ground (Note 12)	−1V to V_{IN}
Boost Pin Voltage	V_{SW} + 8V
Feedback Pin Voltage	−0.3V to 14V
Power Dissipation	Internally Limited
ESD (Note 2)	2 kV
Storage Temperature Range	−65°C to 150°C
Soldering Temperature	
Wave	4 sec, 260°C
Infrared	10 sec, 240°C
Vapor Phase	75 sec, 219°C

Operating Ratings

Supply Voltage	8V to 40V
Junction Temperature Range (T_J)	−40°C to 125°C

Electrical Characteristics

Limits appearing in **bold type face** apply over the entire junction temperature range of operation, −40°C to 125°C. Specifications appearing in normal type apply for $T_A = T_J = 25°C$.

LM2678-3.3

Symbol	Parameter	Conditions	Typical (Note 3)	Min (Note 4)	Max (Note 4)	Units
V_{OUT}	Output Voltage	V_{IN} = 8V to 40V, 100mA ≤ I_{OUT} ≤ 5A	3.3	3.234/**3.201**	3.366/**3.399**	V
η	Efficiency	V_{IN} = 12V, I_{LOAD} = 5A	82			%

LM2678-5.0

Symbol	Parameter	Conditions	Typical (Note 3)	Min (Note 4)	Max (Note 4)	Units
V_{OUT}	Output Voltage	V_{IN} = 8V to 40V, 100mA ≤ I_{OUT} ≤ 5A	5.0	4.900/**4.850**	5.100/**5.150**	V
η	Efficiency	V_{IN} = 12V, I_{LOAD} = 5A	84			%

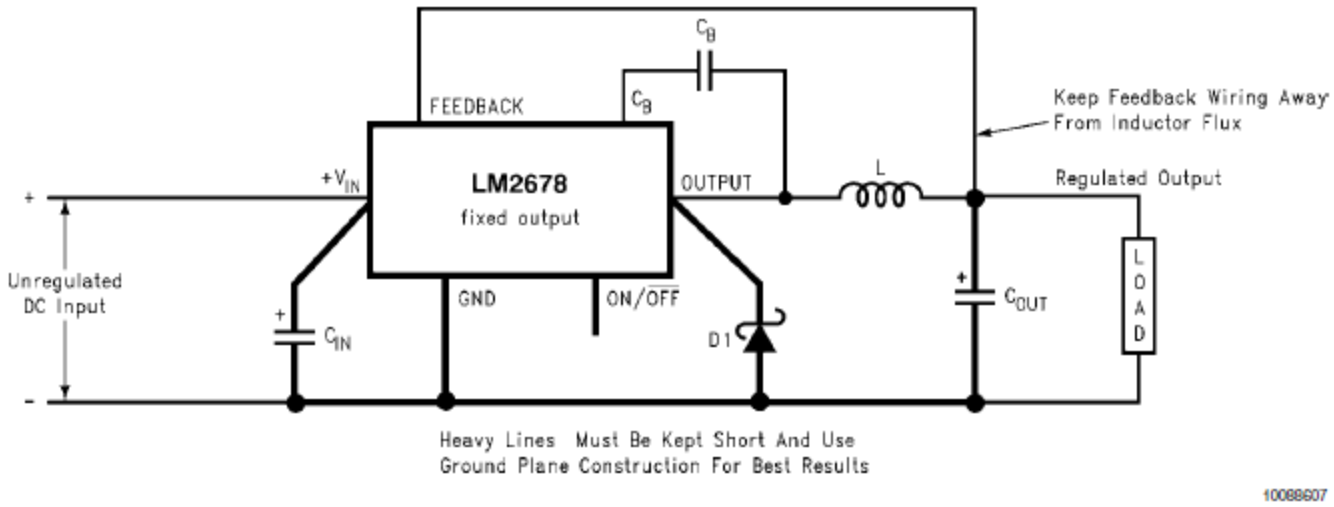
LM2678-12

Symbol	Parameter	Conditions	Typical (Note 3)	Min (Note 4)	Max (Note 4)	Units
V_{OUT}	Output Voltage	V_{IN} = 15V to 40V, 100mA ≤ I_{OUT} ≤ 5A	12	11.76/**11.64**	12.24/**12.36**	V
η	Efficiency	V_{IN} = 24V, I_{LOAD} = 5A	92			%

LM2678-ADJ

Symbol	Parameter	Conditions	Typ (Note 3)	Min (Note 4)	Max (Note 4)	Units
V_{FB}	Feedback Voltage	V_{IN} = 8V to 40V, 100mA ≤ I_{OUT} ≤ 5A V_{OUT} Programmed for 5V	1.21	1.186/**1.174**	1.234/**1.246**	V
η	Efficiency	V_{IN} = 12V, I_{LOAD} = 5A	84			%

Electrical Characteristics



Basic Circuit for Fixed Output Voltage Applications

SIMPLE DESIGN PROCEDURE

Using the nomographs and tables in this data sheet (or use the available design software at http://www.national.com) a complete step-down regulator can be designed in a few simple steps.

Step 1: Define the power supply operating conditions:

Required output voltage

Maximum DC input voltage

Maximum output load current

Step 2: Set the output voltage by selecting a fixed output LM2678 (3.3V, 5V or 12V applications) or determine the required feedback resistors for use with the adjustable LM2678 –ADJ

Step 3: Determine the inductor required by using one of the four nomographs, *Figure 3* through *Figure 6*. Table 1 provides a specific manufacturer and part number for the inductor.

Step 4: Using Table 3 (fixed output voltage) or Table 6 (adjustable output voltage), determine the output capacitance required for stable operation. Table 2 provides the specific capacitor type from the manufacturer of choice.

Step 5: Determine an input capacitor from Table 4 for fixed output voltage applications. Use Table 2 to find the specific capacitor type. For adjustable output circuits select a capacitor from Table 2 with a sufficient working voltage (WV) rating greater than Vin max, and an rms current rating greater than one-half the maximum load current (2 or more capacitors in parallel may be required).

Step 6: Select a diode from Table 5. The current rating of the diode must be greater than I load max and the Reverse Voltage rating must be greater than Vin max.

Step 7: Include a 0.01µF/50V capacitor for Cboost in the design.

FIXED OUTPUT VOLTAGE DESIGN EXAMPLE

A system logic power supply bus of 3.3V is to be generated from a wall adapter which provides an unregulated DC voltage of 13V to 16V. The maximum load current is 4A. Through-hole components are preferred.

Step 1: Operating conditions are:

Vout = 3.3V

Vin max = 16V

Iload max = 4A

Step 2: Select an LM2678T-3.3. The output voltage will have a tolerance of

±2% at room temperature and ±3% over the full operating temperature range.

Step 3: Use the nomograph for the 3.3V device ,*Figure 3*. The intersection of the 16V horizontal line (V_{in} max) and the 4A vertical line (I_{load} max) indicates that L46, a 15µH inductor, is required.

From Table 1, L46 in a through-hole component is available from Renco with part number RL-1283-15-43.

Step 4: Use Table 3 to determine an output capacitor. With a 3.3V output and a 15µH inductor there are four through-hole output capacitor solutions with the number of same type capacitors to be paralleled and an identifying capacitor code given. Table 2 provides the actual capacitor characteristics. Any of the following choices will work in the circuit:

2 x 220µF/10V Sanyo OS-CON (code C5)

2 x 820µF/16V Sanyo MV-GX (code C5)

1 x 3900µF/10V Nichicon PL (code C7)

2 x 560µF/35V Panasonic HFQ (code C5)

Step 5: Use Table 4 to select an input capacitor. With 3.3V output and 15µH there are three through-hole solutions. These capacitors provide a sufficient voltage rating and an rms current rating greater than 2A (1/2 I_{load} max). Again using Table 2 for specific component characteristics the following choices are suitable:

2 x 680µF/63V Sanyo MV-GX (code C13)

1 x 1200µF/63V Nichicon PL (code C25)

1 x 1500µF/63V Panasonic HFQ (code C16)

Step 6: From Table 5 a 5A or more Schottky diode must be selected. For through-hole components only 40V rated diodes are indicated and 4 part types are suitable:

1N5825

MBR745

80SQ045

6TQ045

Step 7: A 0.01µF capacitor will be used for Cboost.

ADJUSTABLE OUTPUT DESIGN EXAMPLE

In this example it is desired to convert the voltage from a two battery automotive power supply (voltage range of 20V to 28V, typical in large truck applications) to the 14.8VDC alternator supply typically used to power electronic equipment from single battery 12V vehicle systems. The load current required is 3.5A maximum. It is also desired to implement the power supply with all surface mount components.

Step 1: Operating conditions are:

Vout = 14.8V

Vin max = 28V

Iload max = 3.5A

Step 2: Select an LM2678S-ADJ. To set the output voltage to 14.9V two resistors need to be chosen (R1 and R2 in *Figure 2*). For the adjustable device the output voltage is set by the following relationship:

$$V_{OUT} = V_{FB}\left(1 + \frac{R_2}{R_1}\right)$$

Where V_{FB} is the feedback voltage of typically 1.21V.

A recommended value to use for R1 is 1K. In this example then R2 is determined to be:

$$R_2 = R_1\left(\frac{V_{OUT}}{V_{FB}} - 1\right) = 1\,k\Omega\left(\frac{14.8V}{1.21V} - 1\right)$$

R2 = 11.23KΩ

The closest standard 1% tolerance value to use is 11.3KΩ

This will set the nominal output voltage to 14.88V which is within 0.5% of the target value.

Step 3: To use the nomograph for the adjustable device, *Figure 6*, requires a calculation of the inductor Volt•microsecond constant (E•T expressed in V•µS) from the following formula:

$$E \cdot T = (V_{IN(MAX)} - V_{OUT} - V_{SAT}) \cdot \frac{V_{OUT} + V_D}{V_{IN(MAX)} - V_{SAT} + V_D} \cdot \frac{1000}{260}\ (V \cdot \mu s)$$

where V_{SAT} is the voltage drop across the internal power switch which is $R_{ds(ON)}$ times I_{load}. In this example this would be typically 0.12Ω x 3.5A or 0.42V and V_D is the voltage drop across the forward bisased Schottky diode, typically 0.5V. The switching frequency of 260KHz is the nominal value to

Parts List for Voltage Regulator Redesign						
Component	**Description**	**Digi-Key #**	**Manafacturer #**	**Quantity**	**Unit Price**	**Price**
National Semiconductor LM2678	Voltage Regulator - TO-220 Package	LM2678T-5.0-ND	LM2678T-5.0/NOPB	3	$7.43	$22.29
Panasonic EEU-FC Capacitor	Through Hole 2200uF capacitor (Cin)	P10309-ND	EEU-FC1V222	3	$1.70	$5.10
Sanyo OS-CON Capacitor	Through Hole 220uF capacitor (Cout)		16SEPC220MD	3	Quote	
Vishay Capacitor	Through Hole 0.01uF capacitor (Cboost)	BC2665CT-ND	K104K10X7RF5UH5	3	$0.37	$1.11
Pulse Engineering Power Inductor	15 uH, 5A	Mouser: 673-P0846	P0846	3	$5.15	$15.45
On Semiconductor Schottky Diode	7.5 A, 45V	MBR745GOS-ND	MBR745G	3	$0.84	$2.52
					Total	**$46.47**

Detailed Pin Descriptions on LM2678

Application Hints

The LM2678 provides all of the active functions required for a step-down (buck) switching regulator. The internal power switch is a DMOS power MOSFET to provide power supply designs with high current capability, up to 5A, and highly efficient operation.

The LM2678 is part of the ***SIMPLE SWITCHER*** family of power converters. A complete design uses a minimum number of external components, which have been pre-determined from a variety of manufacturers. Using either this data sheet or a design software program called ***LM267X Made Simple*** (version 2.0) a complete switching power supply can be designed quickly. The software is provided free of charge and can be downloaded from National Semiconductor's Internet site located at http://www.national.com.

SWITCH OUTPUT

This is the output of a power MOSFET switch connected directly to the input voltage. The switch provides energy to an inductor, an output capacitor and the load circuitry under control of an internal pulse-width-modulator (PWM). The PWM controller is internally clocked by a fixed 260KHz oscillator. In a standard step-down application the duty cycle (Time ON/Time OFF) of the power switch is proportional to the ratio of the power supply output voltage to the input voltage. The voltage on pin 1 switches between Vin (switch ON) and below ground by the voltage drop of the external Schottky diode (switch OFF).

INPUT

The input voltage for the power supply is connected to pin 2. In addition to providing energy to the load the input voltage also provides bias for the internal circuitry of the LM2678. For guaranteed performance the input voltage must be in the range of 8V to 40V. For best performance of the power supply the input pin should always be bypassed with an input capacitor located close to pin 2.

C BOOST

A capacitor must be connected from pin 3 to the switch output, pin 1. This capacitor boosts the gate drive to the internal MOSFET above Vin to fully turn it ON. This minimizes conduction losses in the power switch to maintain high efficiency. The recommended value for C Boost is 0.01µF.

GROUND

This is the ground reference connection for all components in the power supply. In fast-switching, high-current applications such as those implemented with the LM2678, it is recommended that a broad ground plane be used to minimize signal coupling throughout the circuit

FEEDBACK

This is the input to a two-stage high gain amplifier, which drives the PWM controller. It is necessary to connect pin 6 to the actual output of the power supply to set the dc output voltage. For the fixed output devices (3.3V, 5V and 12V outputs), a direct wire connection to the output is all that is required as internal gain setting resistors are provided inside the LM2678. For the adjustable output version two external resistors are required to set the dc output voltage. For stable operation of the power supply it is important to prevent coupling of any inductor flux to the feedback input.

ON/OFF

This input provides an electrical ON/OFF control of the power supply. Connecting this pin to ground or to any voltage less than 0.8V will completely turn OFF the regulator. The current drain from the input supply when OFF is only 50µA. Pin 7 has an internal pull-up current source of approximately 20µA and a protection clamp zener diode of 7V to ground. When electrically driving the ON/OFF pin the high voltage level for the ON condition should not exceed the 6V absolute maximum limit. When ON/OFF control is not required pin 7 should be left open circuited.

DAP (LLP PACKAGE)

The Die Attach Pad (DAP) can and should be connected to PCB Ground plane/island. For CAD and assembly guidelines refer to Application Note AN-1187 at http://power.national.com.

DESIGN CONSIDERATIONS

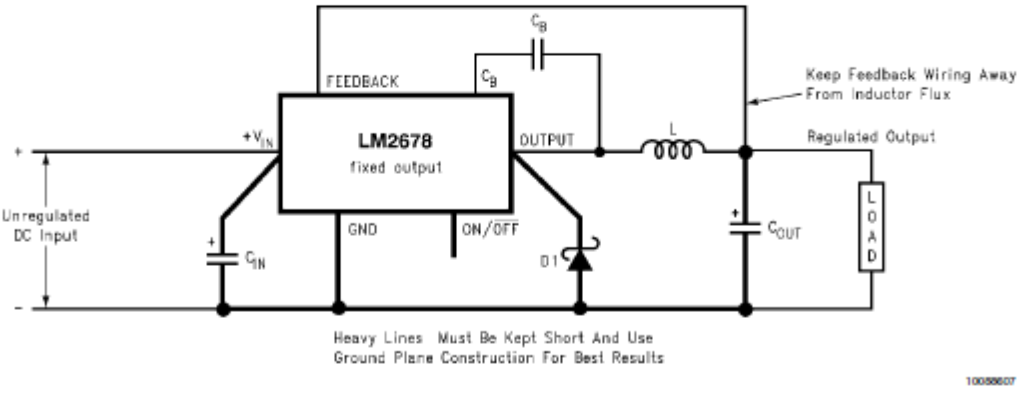


FIGURE 1. Basic circuit for fixed output voltage applications.

Power supply design using the LM2678 is greatly simplified by using recommended external components. A wide range of inductors, capacitors and Schottky diodes from several manufacturers have been evaluated for use in designs that cover the full range of capabilities (input voltage, output voltage and load current) of the LM2678. A simple design procedure using nomographs and component tables provided in this data sheet leads to a working design with very little effort. Alternatively, the design software, ***LM267X Made Simple*** (version 6.0), can also be used to provide instant component selection, circuit performance calculations for evaluation, a bill of materials component list and a circuit schematic.

INDUCTOR

The inductor is the key component in a switching regulator. For efficiency the inductor stores energy during the switch ON time and then transfers energy to the load while the switch is OFF.

Nomographs are used to select the inductance value required for a given set of operating conditions. The nomographs assume that the circuit is operating in continuous mode (the current flowing through the inductor never falls to zero). The magnitude of inductance is selected to maintain a maximum ripple current of 30% of the maximum load current. If the ripple current exceeds this 30% limit the next larger value is selected.

The inductors offered have been specifically manufactured to provide proper operation under all operating conditions of input and output voltage and load current. Several part types are offered for a given amount of inductance. Both surface mount and through-hole devices are available. The inductors from each of the three manufacturers have unique characteristics.

Renco: ferrite stick core inductors; benefits are typically lowest cost and can withstand ripple and transient peak currents above the rated value. These inductors have an external magnetic field, which may generate EMI.

Pulse Engineering: powdered iron toroid core inductors; these also can withstand higher than rated currents and, being toroid inductors, will have low EMI.

Coilcraft: ferrite drum core inductors; these are the smallest physical size inductors and are available only as surface mount components. These inductors also generate EMI but less than stick inductors.

The individual components from the various manufacturers called out for use are still just a small sample of the vast array of components available in the industry. While these components are recommended, they are not exclusively the only components for use in a design. After a close comparison of component specifications, equivalent devices from other manufacturers could be substituted for use in an application.

Important considerations for each external component and an explanation of how the nomographs and selection tables were developed follows.

OUTPUT CAPACITOR

The output capacitor acts to smooth the dc output voltage and also provides energy storage. Selection of an output capacitor, with an associated equivalent series resistance (ESR), impacts both the amount of output ripple voltage and stability of the control loop.

The output ripple voltage of the power supply is the product of the capacitor ESR and the inductor ripple current. The capacitor types recommended in the tables were selected for having low ESR ratings.

In addition, both surface mount tantalum capacitors and through-hole aluminum electrolytic capacitors are offered as solutions.

Impacting frequency stability of the overall control loop, the output capacitance, in conjunction with the inductor, creates a double pole inside the feedback loop. In addition the capacitance and the ESR value create a zero. These frequency response effects together with the internal frequency compensation circuitry of the LM2678 modify the gain and phase shift of the closed loop system.

As a general rule for stable switching regulator circuits it is desired to have the unity gain bandwidth of the circuit to be limited to no more than one-sixth of the controller switching frequency. With the fixed 260KHz switching frequency of the LM2678, the output capacitor is selected to provide a unity gain bandwidth of 40KHz maximum. Each recommended capacitor value has been chosen to achieve this result.

In some cases multiple capacitors are required either to reduce the ESR of the output capacitor, to minimize output ripple (a ripple voltage of 1% of Vout or less is the assumed performance condition), or to increase the output capacitance

to reduce the closed loop unity gain bandwidth (to less than 40KHz). When parallel combinations of capacitors are required it has been assumed that each capacitor is the exact same part type.

The RMS current and working voltage (WV) ratings of the output capacitor are also important considerations. In a typical step-down switching regulator, the inductor ripple current (set to be no more than 30% of the maximum load current by the inductor selection) is the current that flows through the output capacitor. The capacitor RMS current rating must be greater than this ripple current. The voltage rating of the output capacitor should be greater than 1.3 times the maximum output voltage of the power supply. If operation of the system at elevated temperatures is required, the capacitor voltage rating may be de-rated to less than the nominal room temperature rating. Careful inspection of the manufacturer's specification for de-rating of working voltage with temperature is important.

INPUT CAPACITOR

Fast changing currents in high current switching regulators place a significant dynamic load on the unregulated power source. An input capacitor helps to provide additional current to the power supply as well as smooth out input voltage variations.

Like the output capacitor, the key specifications for the input capacitor are RMS current rating and working voltage. The RMS current flowing through the input capacitor is equal to one-half of the maximum dc load current so the capacitor should be rated to handle this. Paralleling multiple capacitors proportionally increases the current rating of the total capacitance. The voltage rating should also be selected to be 1.3 times the maximum input voltage. Depending on the unregulated input power source, under light load conditions the maximum input voltage could be significantly higher than normal operation and should be considered when selecting an input capacitor.

The input capacitor should be placed very close to the input pin of the LM2678. Due to relative high current operation with fast transient changes, the series inductance of input connecting wires or PCB traces can create ringing signals at the input terminal which could possibly propagate to the output or other parts of the circuitry. It may be necessary in some designs to add a small valued (0.1µF to 0.47µF) ceramic type capacitor in parallel with the input capacitor to prevent or minimize any ringing.

CATCH DIODE

When the power switch in the LM2678 turns OFF, the current through the inductor continues to flow. The path for this current is through the diode connected between the switch output and ground. This forward biased diode clamps the switch output to a voltage less than ground. This negative voltage must be greater than –1V so a low voltage drop (particularly at high current levels) Schottky diode is recommended. Total efficiency of the entire power supply is significantly impacted by the power lost in the output catch diode. The average current through the catch diode is dependent on the switch duty cycle (D) and is equal to the load current times (1-D). Use of a diode rated for much higher current than is required by the actual application helps to minimize the voltage drop and power loss in the diode.

During the switch ON time the diode will be reversed biased by the input voltage. The reverse voltage rating of the diode should be at least 1.3 times greater than the maximum input voltage.

BOOST CAPACITOR

The boost capacitor creates a voltage used to overdrive the gate of the internal power MOSFET. This improves efficiency by minimizing the on resistance of the switch and associated power loss. For all applications it is recommended to use a 0.01µF/50V ceramic capacitor.

ADDITIONAL APPLICATION INFORMATION

When the output voltage is greater than approximately 6V, and the duty cycle at minimum input voltage is greater than approximately 50%, the designer should exercise caution in selection of the output filter components. When an application designed to these specific operating conditions is subjected to a current limit fault condition, it may be possible to observe a large hysteresis in the current limit. This can affect the output voltage of the device until the load current is reduced sufficiently to allow the current limit protection circuit to reset itself.

Under current limiting conditions, the LM267x is designed to respond in the following manner:

1. At the moment when the inductor current reaches the current limit threshold, the ON-pulse is immediately terminated. This happens for any application condition.
2. However, the current limit block is also designed to momentarily reduce the duty cycle to below 50% to avoid subharmonic oscillations, which could cause the inductor to saturate.
3. Thereafter, once the inductor current falls below the current limit threshold, there is a small relaxation time during which the duty cycle progressively rises back above 50% to the value required to achieve regulation.

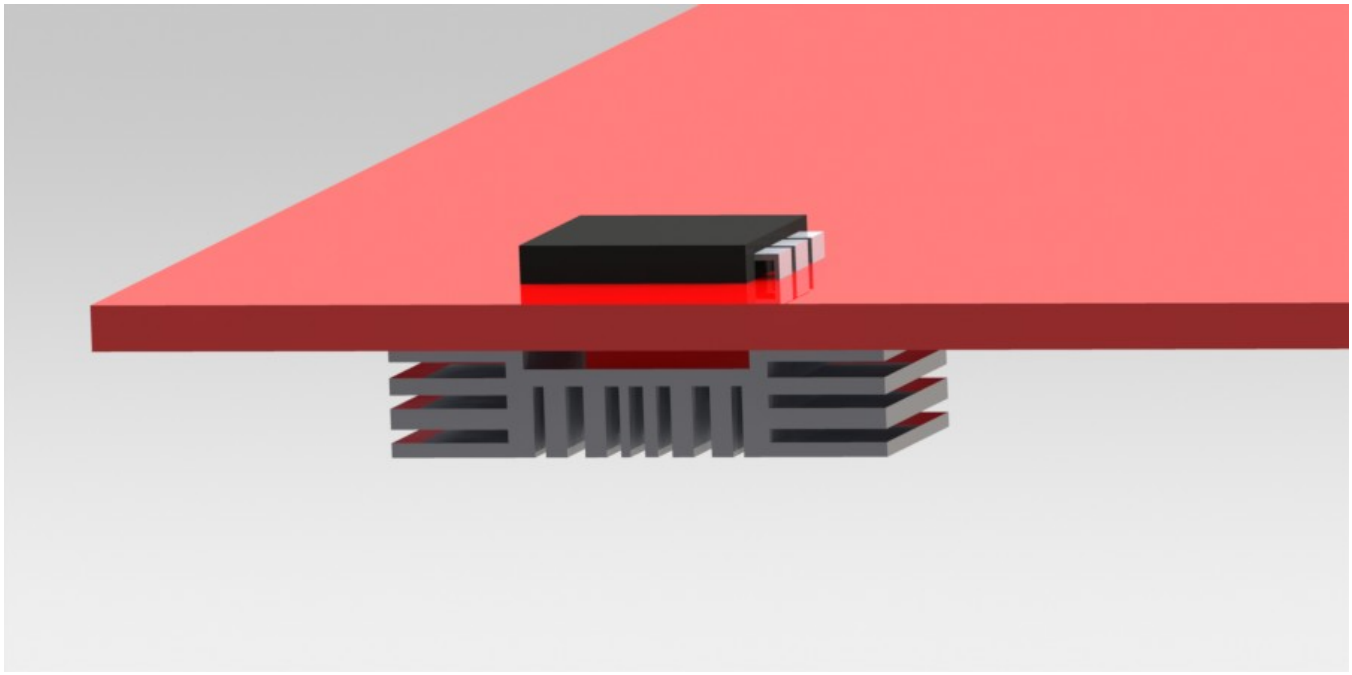
If the output capacitance is sufficiently 'large', it may be possible that as the output tries to recover, the output capacitor charging current is large enough to repeatedly re-trigger the current limit circuit before the output has fully settled. This condition is exacerbated with higher output voltage settings because the energy requirement of the output capacitor varies as the square of the output voltage (½CV²), thus requiring an increased charging current.

A simple test to determine if this condition might exist for a suspect application is to apply a short circuit across the output of the converter, and then remove the shorted output condition. In an application with properly selected external components, the output will recover smoothly.

Practical values of external components that have been experimentally found to work well under these specific operating conditions are C_{OUT} = 47µF, L = 22µH. It should be noted that even with these components, for a device's current limit of I_{CLIM}, the maximum load current under which the possibility of the large current limit hysteresis can be minimized is $I_{CLIM}/2$. For example, if the input is 24V and the set output voltage is 18V, then for a desired maximum current of 1.5A, the current limit of the chosen switcher must be confirmed to be at least 3A.

Heat Sink

Current Design



Current Voltage Regulator and Heat Sink Layout

- Issues
  - Heat Sink is not in direct contact with voltage regulator
  - Voltage regulator is overheating and the heat sink has no way of cooling the regulator back to the ambient temperature
  - Make sure the proposed heat sink is rated to the necessary watt dissipation of voltage regulator design

$$Thermal\ Power\ Dissipation, P = I_C * \Delta V \quad (1)$$

$$Thermal\ Resistance\ R_{th} = \frac{T_{max} - T_{air}}{P} \quad (2)$$

Thermal Power Dissipation: Power (watts) that will be released as heat during voltage step down.

Thermal Resistance: Heat sink's resistance to heat flow. Refers to the ability to drop the temperature per watt. A low thermal resistance refers to a better heat sink.

Power Rating Required			
Panda Board Voltage Regulator		**New "Digital 5V" Supply Regulator**	
Peripheral	Value	Peripheral	Value
Current (A)	4	Current (A)	2.545
Thermal Power (W)	28	Thermal Power (W)	17.815
Rth (°C/W)	2.68	Rth (°C/W)	4.21

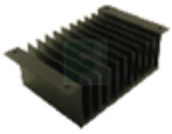
Calculations for Required Heat Sink

Using *Tmax* = 100 °C (212 °F) and *Tmin* = 25 °C (77 °F), the required rating necessary for each voltage regulation system is given in the calculations for required heat sink table . Proper safety margins are necessary to ensure functionality at maximum circuit limits.

Proposed Design

PERFORMANCE, LOW PROFILE HEAT SINKS FOR POWER MODULES & IGBT'S

394, 395, 396 SERIES

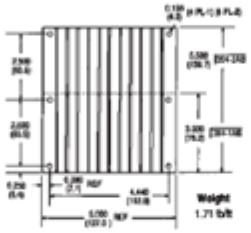


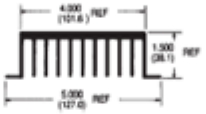
Standard P/N	Overall Dimensions: in. (mm) Length in. (mm)	Height in. (mm)	Width in. (mm)	Device Base Mounting Area (mm)	Base Mounting Holes	Thermal Resistance at Typical Load Natural Convection (θsa)(1) (°C/W)	Forced Convection (θsa) (°C/W @ 500 LFM)
394-1AB	3.000 (76.2)	1.500 (38.1)	5.000 (127.0)	101 x 76	4	1.85	0.90
394-2AB	5.500 (139.7)	1.500 (38.1)	5.000 (127.0)	101 x 139	6	1.51	0.60
395-1AB	3.000 (76.2)	2.500 (63.5)	5.000 (127.0)	50 x 76	4	1.10	0.50
395-2AB	5.500 (139.7)	2.500 (63.5)	5.000 (127.0)	50 x 139	6	0.90	0.32
396-1AB	3.000 (76.2)	1.380 (35.1)	5.000 (127.0)	50 x 76	4	1.85	1.07
396-2AB	5.500 (139.7)	1.380 (35.1)	5.000 (127.0)	50 x 139	6	1.51	0.64

Note: 1.Thermal resistance values shown are for black anodized finish at 50°C rise above ambient.

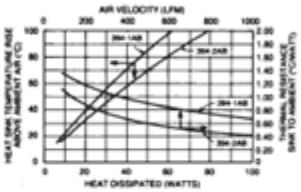
MECHANICAL DIMENSIONS

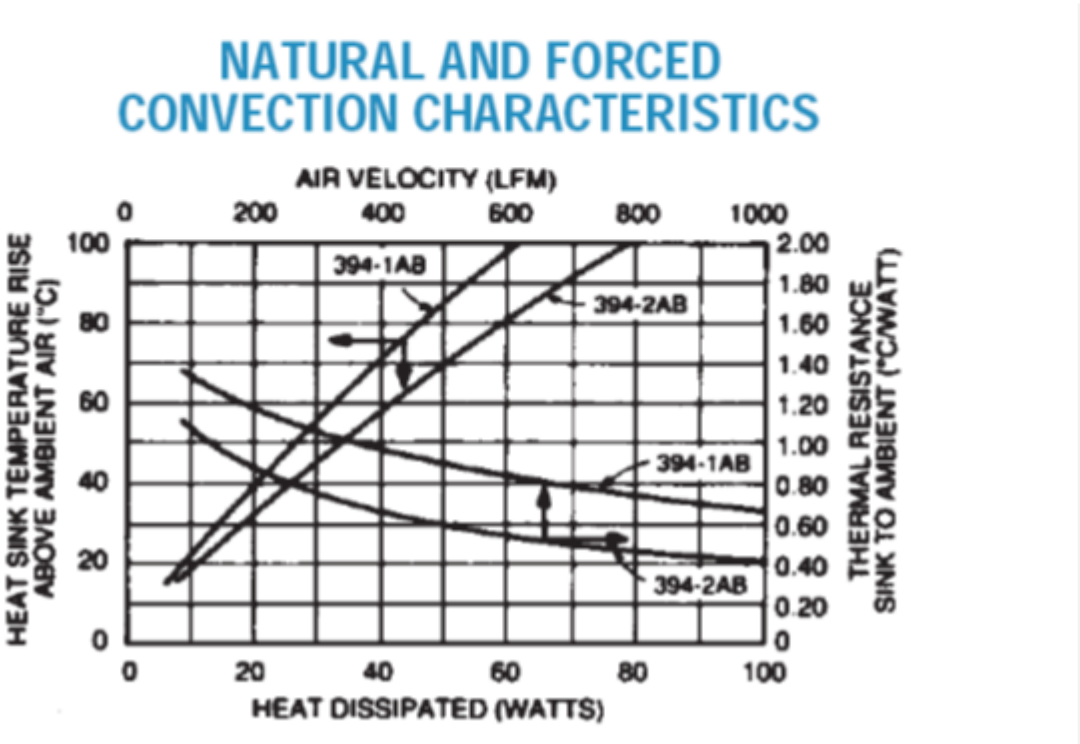
394 SERIES
(EXTRUSION PROFILE 7332)





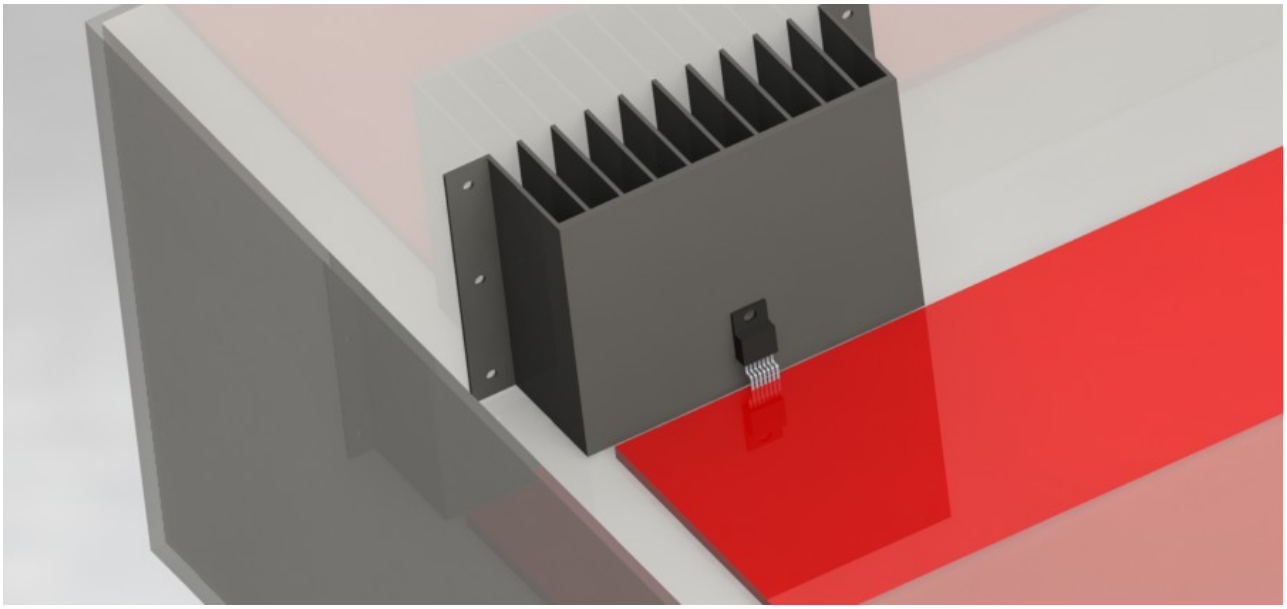
NATURAL AND FORCED CONVECTION CHARACTERISTICS





Proposed Heat Sink

Looking at the 394-1AB heat sink, the thermal resistance is at 1.85 °C/W which gives a decent safety margin and the power dissipation capability is well above the given constraints. Cost $21.95 * 2= $43.90 available at newark.com and www.futureelectronics.com



Proposed Heat Sink PCB Layout

As shown, the voltage regulator will be direct in contact with the heat sink. The voltage regulator will be bent at a 90° angle at the leads and positioned at edge of the PCB board. Using thermal paste will ensure a direct connection and allow for maximum functionality of the heat sink.

Wandering Ambassador Diagnostic Protocol Template - Draft

To be finalized by end of MSD II

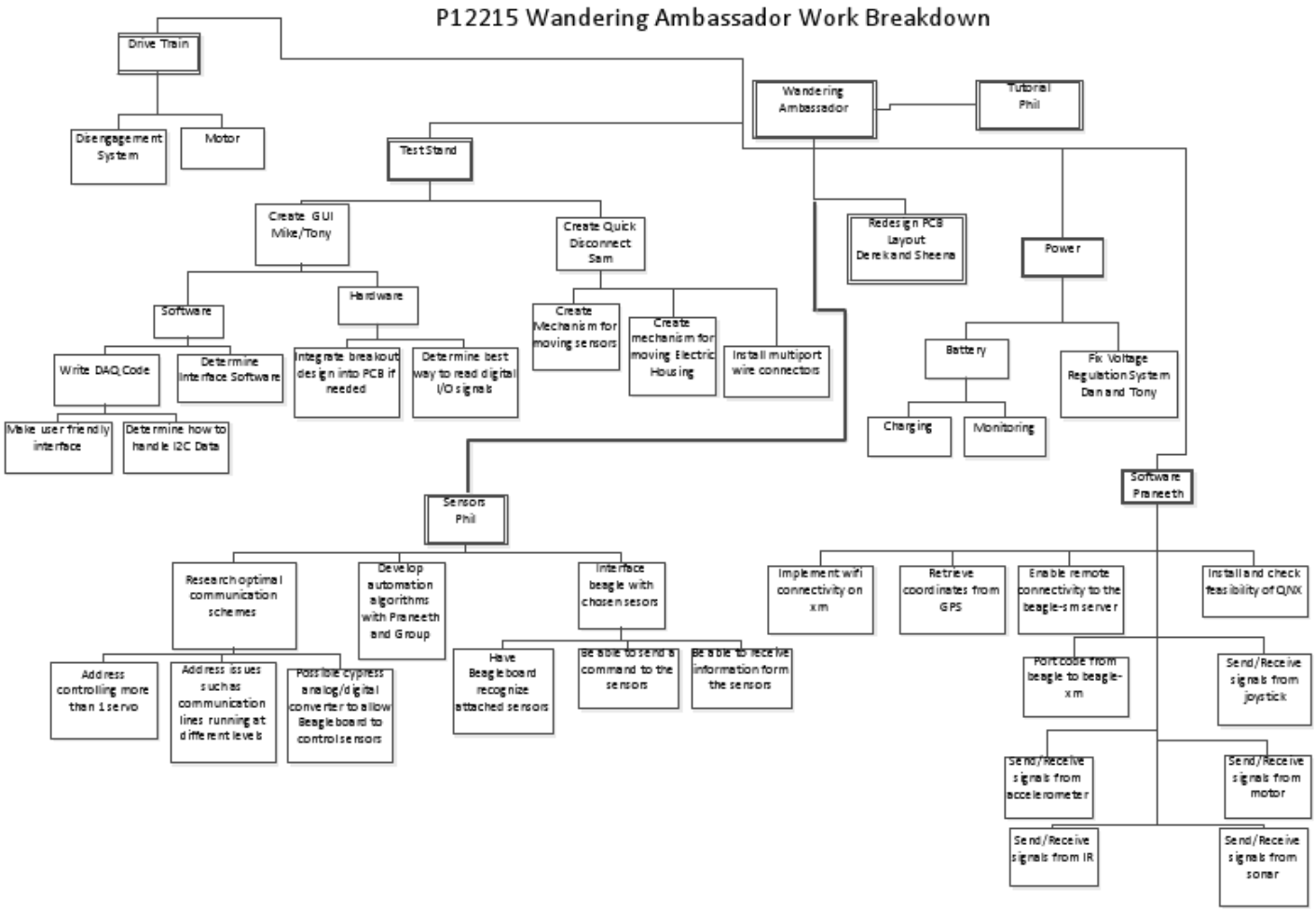
1. ____ Place a check mark through each of the items below as you progress through the test procedure. If a test fails, place an X and move on.Hand the checklist to the team member responsible in that area for further action
2. ____ Ensure all ports are connected by labels and color codes as established in the PORT MAP in user manual.
3. ____ Confirm all LED's are on
4. Pandaboard
    a. ____ Insert the SD card labeled Kozio diagnostics into the Pandaboard and power the system on.
    b. ____ Further instructions will be provided once kozio diagnostics is evaluated
5. Sonar sensor
    a. ____ Turn on the system normally, and execute the "SonarX_Test" program located at / home/systemtests/sonar/
    b. ____ Place an object in front of the sonar being tested and verify the distance being reported is within 20% error
6. GPS
    a. ____ Move the system outdoors, and wait few minutes.
    b. ____ Open the "GPS Test"application and ensure the coordinates are close to "43.165496, -77.611504"
7. Motor
    a. ____ Ensure the person testing is attentive and athletic
    b. ____ Open the Motor test application and test of the options provided
        i. ____ Engage left motor
        ii. ____ Engage right motor
8. IR sensor
    a. ____ Turn on the system normally, and execute the "IRX_Test" program located at /home/ systemtests/IR/
    b. ____ Place an object infront of the sensorbeing tested and verify the distance being reported is within 20% error
9. Servo
    a. ____ Open the servo test application, select each servo and test each of the functions
        i. ____ Turn left
        ii. ____ Turn right
10. Remote Control
    a. ____ Press R1 and L1 and validate that the ambassador is moving as expected
11. Voltage Regulators
    a. ____ Green LED illuminated on "Panada - Digital 5V" regulator
    b. ____ Green LED illuminated on "Digital 5V" regulator
    c. ____ Green LED illuminated on "Analog 5V" regulator
    d. ____ Green LED illuminated on "Digital 3.3V" regulator
    e. ____ Green LED illuminated on "Analog 3.3V" regulator

f. ____ Load current less than 5A on “Panda - Digital 5V” regulator
g. ____ Load current less than 5A on “Digital 5V” regulator
h. ____ Load current less than 3A on “Analog 5V” regulator
i. ____ Load current less than 3A on “Digital 3.3V” regulator
j. ____ Load current less than 3A on “Analog 3.3V” regulator

12. Diagnostic GUI
    k. __Ensure connection between computer and pandaboard
    l. __Ensure signals are being received by pandaboard and then are properly received by computer
    m. __Send signals from sensors directly to computer to make sure the sensors are functioning properly
    n. __GUI testing/development
13. PCB
    o. __Check voltages at test points

Bill of Materials

Item	Part Description	Supplier	Part #	# Needed	Price Per Unit	Total Price	Part	Lead Time
1	Dynex Mini Card Reader	Best Buy	842-6303	1	$9.99	$9.99	MicroSD Card Reader	
2	Trans Desk 5VDC 3.6A	Digi-Key	T1075-P5P-ND	1	$15.93	$15.93	Power Adapter	
3	Adapter Wall R-Series 10W 5V	Digi-Key	993-1050-ND	1	$13.39	$13.39	Power Adapter	
4	6' HDMI to DVI-D M / M Cable, Black	Meritline	192-828-001	1	$5.99	$5.99	HDMI Cable	
5	Voltage Regulator - TO-220 Package	Digi-Key	LM2678T-5.0-ND	3	$7.43	$22.29	National Semiconductor LM2678	2-3 days
6	Through Hole 2200uF capacitor (Cin)	Digi-Key	P10309-ND	3	$1.70	$5.10	Panasonic EEU-FC Capacitor	2-3 days
7	Through Hole 220uF capacitor (Cout)			3			Sanyo OS-CON Capacitor	Getting quote
8	Through Hole 0.01uF capacitor (Cboost)	Digi-Key	BC2665CT-ND	3	$0.37	$1.11	Vishay Capacitor	2-3 days
9	15 uH, 5A	Mouser	673-P0846	3	$5.15	$15.45	Pulse Engineering Power Inductor	2-3 days
10	7.5 A, 45V	Digi-Key	MBR745GOS-ND	3	$0.84	$2.52	On Semiconductor Schottky Diode	2-3 days
11	Heat Sink	Future Electronics	394-1AB	2	$21.95	$43.90		Calling For Availability
12	Altium License	Altium		1	$120	$120	Custom Board Front-End Design	
13	DieHard Marine Deep Cycle/RV Battery			1	$94.99	$94.99	Power Supply	


P12215 Wandering Ambassador Work Breakdown
Drive Train
Disengagement System
Motor
Wandering Ambassador
Tutorial Phil
Test Stand
Create GUI Mike/Tony
Software
Write DAQ Code
Determine Interface Software
Make user friendly interface
Determine how to handle I2C Data
Hardware
Integrate breakout design into PCB if needed
Determine best way to read digital I/O signals
Create Quick Disconnect Sam
Create Mechanism for moving sensors
Create mechanism for moving Electric Housing
Install multiport wire connectors
Redesign PCB layout Derek and Sheena
Power
Battery
Charging
Monitoring
Fix Voltage Regulation System Dan and Tony
Sensors Phil
Research optimal communication schemes
Address controlling more than 1 servo
Address issues such as communication lines running at different levels
Possible cypress analog/digital converter to allow Beagleboard to control sensors
Develop automation algorithms with Praneeth and Group
Interface beagle with chosen sesors
Have Beagleboard recognize attached sensors
Be able to send a command to the sensors
Be able to receive information form the sensors
Software Praneeth
Implement wifi connectivity on xm
Retrieve coordinates from GPS
Enable remote connectivity to the beagle-xm server
Install and check feasibility of QNX
Port code from beagle to beagle-xm
Send/Receive signals from joystick
Send/Receive signals from accelerometer
Send/Receive signals from motor
Send/Receive signals from IR
Send/Receive signals from sonar

MSD II Tentative Plans For Project Crew

Team Member	Plan
Praneeth Pulusani	- Setup a comprehensive development environment (1 week) - Implement Pandaboard diagnostics (1 week) - Program/interface the connected peripherals and accessories in conjunction with Phil (3 weeks) - Interface the software controls on the system with the remote(2 weeks) - Create a visual interface on the pandaboard for the user (2 weeks) - Ensure testability of the attached peripherals through software. (on going)
Sam Stats	- Alterations to mule to support the electronic housing and battery - Convert electronic housing for quick disconnect system - Install bracketing system on mule and WAM ensure quick disconnect system for sensors is functioning - Help develop debugging protocol
Phillip Tatti	-Write code and implement Sonars with Cypress PSoC. This will take in distance data and store it to make it available for Pandaboard if needed (2-3 weeks) -Write code and implement IR sensors with PSoC. Similar interaction with Pandaboard. (1week) -Write code and implement accelerometer with PSoC. Onboard interrupt to reduce latency (1 week) -Write PWM code for the motors on the PSoC (1 week) -Write and test navigation algorithm, Roomba style (2 weeks) -Setup communication between PSoC and Pandaboard using I2C. This is to allow more advanced algorithms to run from Panda. (2 weeks

Dan Massar	-Changes to voltage regulator design based on feedback from DDR (1 week) -Prototype and test voltage regulator design (1 week) -Coordinate with Derek to implement voltage regulator design in PCB layout - Coordinate with Derek to implement LEDs and test points associated with voltage regulator design (1-2 weeks combined with last task) - Test voltage regulator design on new PCB (1 week) -Create document for future groups detailing current capabilities of voltage regulators to ensure they aren't overloaded again (1 week)
Tony Lanza	-Changes to heat sink design based on DDR feedback (1 week) -Prototype and test heat sink with Dan's voltage regulator (1 week) -Coordinate with Derek to ensure proper regulator positioning on PCB layout -Establish TCP connection between computer and Pandaboard (3 weeks) -Coding to receive proper signal for GUI (2 week) -Develop GUI with Mike to display debugging diagnostics (1 week) -Create document for testing - focus on how to establish connection btw Pandaboard and Computer (1 week) -If unable to establish TCP connection research Kozio (1 week) -Develop Kozio for debugging purposes (2 weeks) -Develop GUI to display Kozio signals (1 week)
Sheena Mital Derek Badon	- Finalize Schematics - PCB Layout Design (2 weeks) - Stuff PCB (1 week) - Test and debug PCB (2 weeks)